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THE MIGRATION OF HARMOLITA GRANDIS FORM MINUTUM: AN IMPORTANT FACTOR IN ITS CONTROL[1]

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During the spring of 1919, *Harmolita grandis* was found to be present in unusual numbers throughout the eastern portion of the great wheat belt. It was evident that should no control measures be used, the infestation might develop into a very serious one within a few years.

Because of the fact that the spring form of this species cannot migrate long distances (it being for the most part wingless) rotation of crops has been a long approved recommendation for the control of this important wheat pest. A search of the literature on this subject failed to reveal any definite data concerning the migratory powers of the spring form of this species. In as much as this has a direct bearing upon the kind of rotation that will effectively control this species, and since the writers have obtained definite data along this line, they deemed it worthy of publication.

It is a well known fact that the spring form of *H. grandis*, although wingless, can migrate short distances by its pedal efforts. It is also generally known that this insect hibernates for the most part in the stubble of the previous year's crop. This means that in case wheat is sown adjacent to the stubble of the previous year's wheat crop, the edge of this field will become infested by the spring form, which comes off the stubble. The second generation individuals which are winged and strong flyers, can then emerge from this infested strip and infest the entire field and even adjacent fields. It is the intention of the writers to show by definite data the distance the spring form of this species can migrate and

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thus determine the distance that wheat can be sown from stubble of the previous year's crop, without danger of infestation.

The following is the method by which these data were obtained. Wheat fields were selected adjacent to stubble, and samples taken at ten yard intervals from the edge of the field next to the stubble up to 100 yards toward the center. In every case, fields were selected which were in a crop other than wheat the previous year, in order to eliminate possible infestation caused by adults coming from the stubble on improperly plowed soil. Each sample consisted of three linear feet of drill row, each foot taken at an interval of five yards in the same row. These samples were brought to the laboratory and carefully examined, the percentage of culms infested by this species being recorded. In this way the distance the adults migrated from the stubble was definitely determined, it being established by the area of infestation. In all cases the infestation was heaviest adjacent to the stubble and decreased in a regular manner with increasing distance from the stubble.

Samples which were taken from eight fields were carefully examined and infestation percentages recorded. In all 280 linear feet of drill row representing 12,276 culms were handled, each culm being carefully examined to detect the presence of this species. The tabulated data from these examinations are found in the following table:

TABLE I

Fields	Distance from stubble	Linear ft. drill row counted	No. culms examined	No. culms infested with *H. grandis*	Per cent infestation
8	Next to stubble	26	1,093	133	12.1
8	10 yds.	26	1,204	58	4.8
8	20 yds.	26	1,103	27	2.4
8	30 yds.	26	1,139	18	1.6
8	40 yds.	26	1,156	7	0.6
8	50 yds.	26	1,171	4	0.4
8	60 yds.	26	1,088	1	0.09
8	70 yds.	26	1,038	1	0.10
8	80 yds.	26	1,158	1	0.08
8	90 yds.	24	1,025	1	0.10
8	100 yds.	24	1,101	0	0.0
			12,276		

NOTE: Samples from field 8 consisted of five linear feet of drill row except at 90 and 100 yards out which consisted of three linear feet.

From the above table and curve it can be seen that the greater part of the infestation occurred within ten yards of the standing stubble, and beyond 30 yards the infestation became practically negligible. The amount of infestation varied markedly in the eight fields, ranging from 20.1 per cent to 6.2 per cent at the stubble, but in every case it decreased in practically the same ratio as the distance from the stubble increased. These data show that under ordinary conditions very few of the wingless

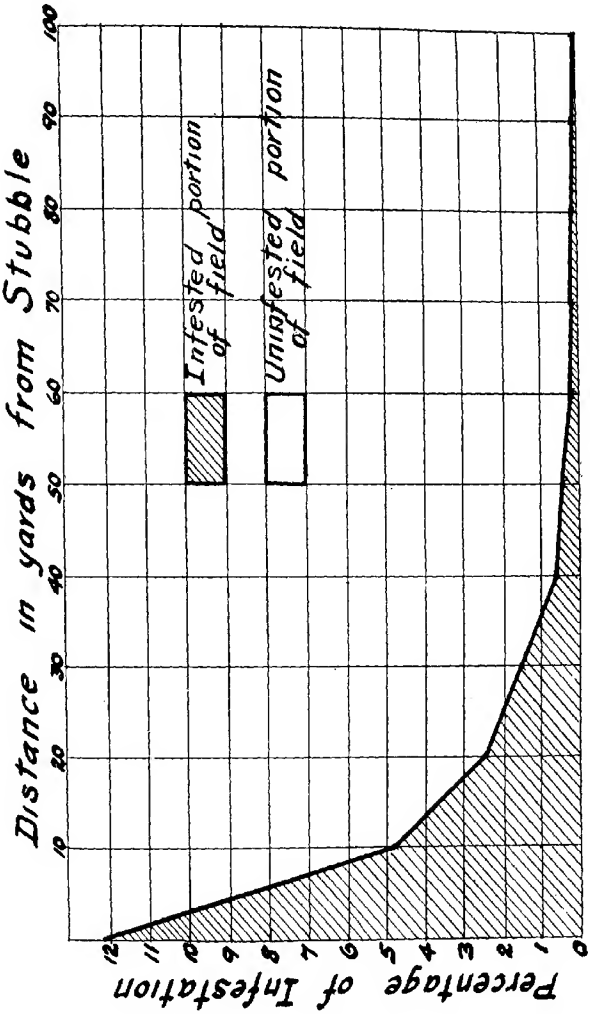

Fig. 21. Curve constructed from the data found in Table I, showing the exact location of the percentages of infestation at various distances from the standing stubble.

adults of this species will migrate farther than 30 yards from the stubble which marked their emerging place.

Several fields which were in wheat the previous year were examined and only a trace of the spring generation of this species was found, and this only where the stubble of the previous year's crop had been improperly plowed. In one field which was in wheat the previous year, a count was taken 100 yards from the edge and showed no infestation; 150 yards showed an infestation of 0.94 per cent and 200 yards, none. From this it can be seen that by far the greater part of the infestation from this generation occurs in those fields which are adjacent to standing stubble of the previous year's wheat crop and within 30 yards of the edge.

Plate 17, 3 of the accompanying figures is an illustration of a plant infested by the spring form of this species. The four tillers on the right are infested. The leaves are broader than normal, darker green, and the center shoot is absent. They appear very much as if they were infested by Hessian fly. The four tillers on the left are normal healthy ones. The isolation of the infestation by the wingless spring generation was very apparent in some of the fields. At the edge adjacent to the stubble the wheat was very thin and dwarfed, which is characteristic of a heavy infestation from this species. Plate 17, 1 and 2 show this condition very well. Both were taken on the same day in the same field only 50 yards apart. Both were focused at the same distance. The first generation infestation was 19 per cent and the second generation infestation 85 per cent at the spot where the first picture was taken. At the location of the second picture there was none of the first generation found but a second generation infestation of about 50 per cent.

An examination of the volunteer wheat in the several stubble fields was made and in every case it was very highly infested with spring generation. Where volunteer wheat is abundant in the stubble fields which are harboring the over-wintering pupæ, it simply acts as a breeding place whereby the wingless first generation can oviposit, thus allowing the strong flying second generation to complete its task of infesting all the wheat in the vicinity.

Having found that practically all of the first brood was located along the edge (outer 30 yards) of wheat fields adjacent to standing stubble, and in volunteer wheat in the stubble, next it was decided to determine to what extent the winged second generation which came from these infested places could infest the wheat in the surrounding vicinity.

Counts were made in the same eight fields for second generation infestation but this time, instead of using ten yard intervals from the stubble, 50 yards were used and only four counts made, namely, next to stubble, at 50, 100 and 150 yards. The counts were made similar to those described above, three linear feet of drill row being taken at three


1


2


3

different places in the same row. Only the culms which had "shot" and were jointed were counted, as it is in these that the adults of the second generation oviposit.

The following table shows the location of the second generation infestation, the percentages being an average of the eight fields:

TABLE II. SECOND GENERATION INFESTATIONS ON THE SAME EIGHT FIELDS THAT THE FIRST GENERATION COUNTS WERE MADE

No. of fields	Linear ft. drill row	Distance from stubble	Tillers counted	Tillers infested	Per cent infestation
8	24	Next to stubble	448	227	50.7
8	24	50 yds.	423	100	23.6
8	24	100 yds.	413	53	12.8
8	24	150 yds.	409	26	6.4

On examining the data obtained from these counts it can be seen that although the heaviest infestation remained in those parts of the fields nearest the standing stubble, comparatively high infestations were found even at 150 yards, which is approximately the middle of most of the fields used in the counts. On the other hand the infestation caused by the first generation stopped at about 30 yards. This shows that the strong flying adults of the second generation will infest an entire field even though they come from a narrow infested strip or a small plot of volunteer wheat in or near standing stubble.

Since it has been shown that the second generation can infest an entire field next to standing stubble, the question now arises, are these second generation individuals able to infest wheat fields which are isolated from standing stubble areas. It has already been stated that practically none of the first generation could be found in last year's wheat which had been properly plowed. It was decided to make second generation counts in fields which were not adjacent to standing stubble. Also to determine the efficiency of plowing under the stubble of the previous year's crop, two types of these fields were taken; those in wheat last year, the stubble having been plowed under, and those in a crop other than wheat the previous year. Since all other conditions in these two classes of fields were practically identical, any marked variation in the percentages of infestation could be undoubtedly due to the fact that it came from the plowed-under stubble in the form of early wingless generation, and hence, on to the second generation infestation.

The counts were made in the following manner: Three linear feet of drill row were taken at five-yard intervals in the same row, these samples being taken at four places in each field, at the edge, 50 yards, 100 yards and 150 yards from the edge. The samples were taken to the laboratory and each culm carefully dissected and infestations recorded.

The following curves show in a graphic way how the winged second generation greatly increases its area of infestation over the area infested by the first generation. The curves represent the infestation of eight fields by both generations and are platted with equal value.

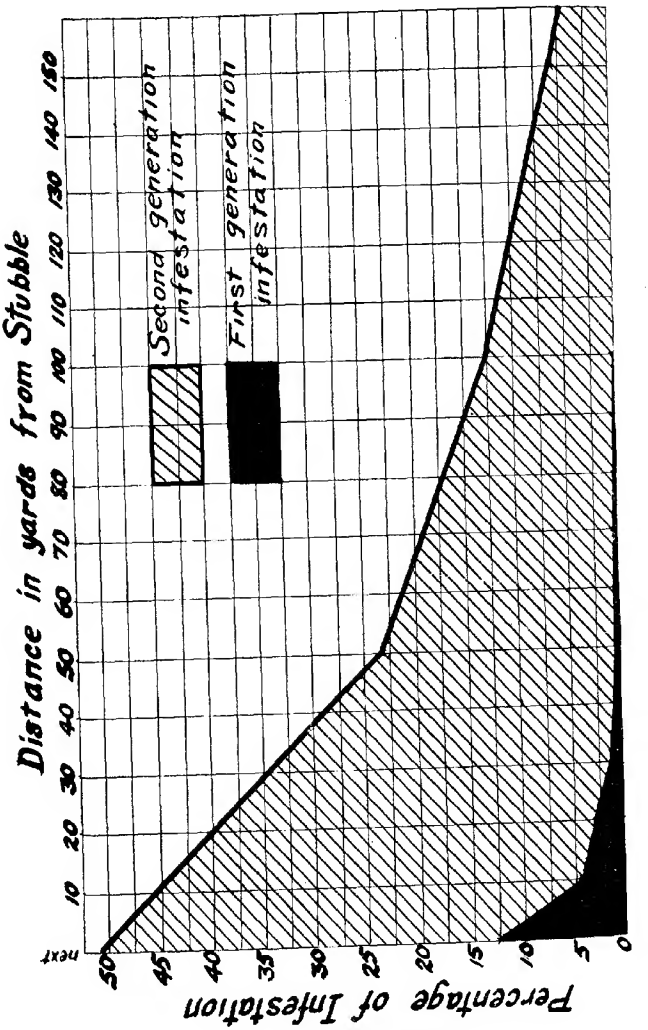

Fig. 22. Curves based on Table II.

Data were taken from seven fields which were in wheat last year but not next to standing stubble. The results are found in the table following:

TABLE III. SECOND GENERATION COUNTS ON SEVEN FIELDS IN WHEAT LAST YEAR BUT NOT NEXT TO STANDING STUBBLE

No. of fields	Linear feet	Distance from edge	Tillers counted	Tillers infested	Per cent infestation
7	21	At edge	318	45	14.1
7	21	50 yds.	365	34	9.6
7	21	100 yds.	367	57	15.5
7	21	150 yds.	374	25	6.7
			Total 1,414	161	Average 11.6%

The above table shows that the infestation, although markedly lighter than in fields adjacent to standing stubble, was fairly uniform throughout the fields.

Similar data were taken from eight fields which were in a crop other than wheat last year and at the same time not next to standing wheat stubble. The results from these eight fields are found in the following table:

TABLE IV. SECOND GENERATION COUNTS ON EIGHT FIELDS NOT IN WHEAT LAST YEAR AND NOT NEXT TO STANDING STUBBLE

No. of fields	Linear ft. drill row	Distance from stubble	Tillers counted	Tillers infested	Per cent infestation
8	24	At edge	458	64	13.9
8	24	50 yds.	465	50	10.7
8	24	100 yds.	498	34	6.8
8	24	150 yds.	498	47	9.6
			Total 1,919	195	Average 9.9%

Again the infestation was fairly uniform throughout the field. Although these fields were not in wheat last year nor next to standing stubble, the infestation from this species was practically the same (very slightly less) as fields on plowed wheat stubble. This is shown in the accompanying graph.

The fact that there was no great difference in the infestation in fields which were and were not in wheat the previous year, that is in fields not adjacent to stubble, tends to show that the plowing under of stubble is fairly efficient in the control of this species. If the first generation adults were able to emerge from plowed under stubble, surely there would be a much greater infestation in those fields which were in wheat last year.

Since we find the ordinary infestation in fields isolated from standing stubble which were not in wheat last year, the question arises "where is the source of infestation in these isolated fields?" This can be answered in only one way. The second generation must come from the first and since practically all of the first generation is found near the edge of the

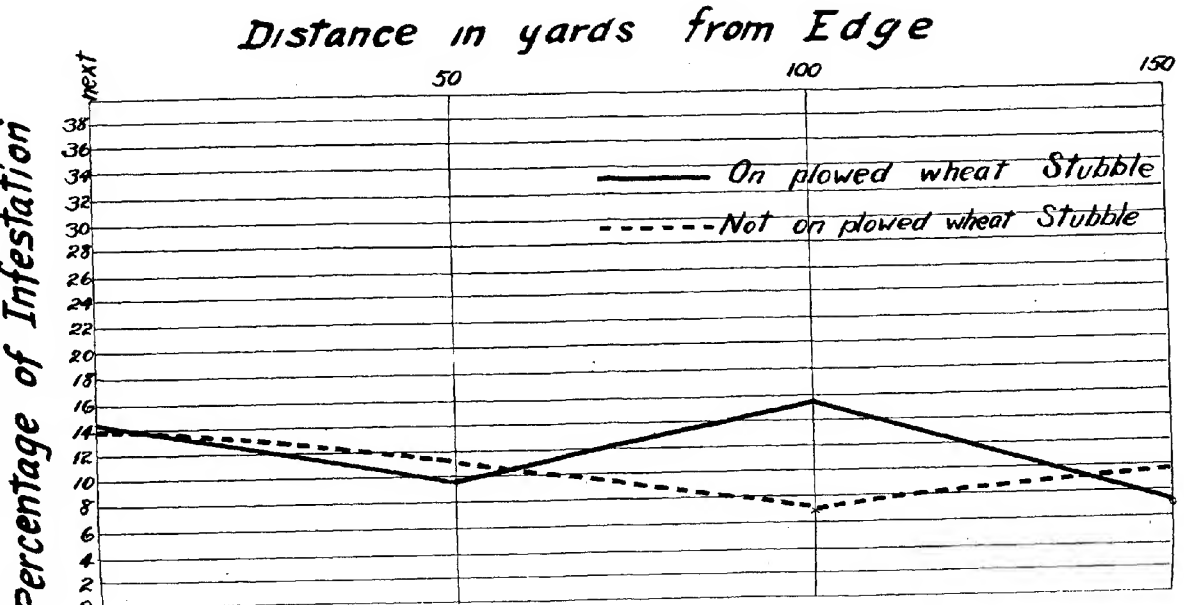

Fig 23. Graph based on Table III.

wheat fields adjacent to stubble or in volunteer wheat in or near stubble, the source of infestation of these isolated fields must originate from these places. These data prove that the winged second generation are strong flyers and emerge from wheat in or very near standing stubble, scatter themselves broadcast, and infest all wheat fairly uniformly over the whole general neighborhood.

Because of the general distribution of the second generation it is certainly not practical to attempt to apply control measures here. The point of attack is certainly in the first generation, the infestation of which is always very limited in area.

It has already been stated that the plowing under of stubble is effective in preventing further infestation from this species. This is one more reason added to the list why wheat stubble should not be left standing after harvest any longer than possible. In some cases, however, farmers find it impossible to plow under the stubble. In this event, wheat should not be sown adjacent to this infested stubble as shown by the facts already set forth. In the data compiled in Table I, it is seen that practically none of the first generation will migrate more than 30 yards to oviposit. This is the key to the whole situation. By planting wheat not closer than 30 yards to standing stubble, one is fairly safe from infestation. Where the stubble can be thrown under without plowing up a hay crop, it should be, but where the hay crop is to be left with the stubble, the following year's wheat should not be sown within 30 yards of it. If it should be, it will act merely as a breeding place for the first generation and the resulting winged second generation will then infest the whole field and nearby fields as well, as is clearly shown by the data embodied in this paper.

It is also essential to keep down all volunteer wheat in or near stubble. This is most apt to spring up around old shock bottoms. This volunteer wheat will act as a breeding place exactly as will wheat sown next to stubble.

Summary

In summarizing the data set forth in this paper, the writers wish to emphasize the following points: Should *H. grandis* increase at its present rate, a great deal of damage will result in the wheat growing region of the United States. The pest hibernates in the stubble and the wingless first generation will infest adjacent wheat or volunteer wheat in or near standing stubble, as it affords a breeding place whereby the first generation can survive, thus exposing the entire neighborhood to infestation from the strong flying second generation. Should the wingless first generation be deprived of its natural breeding places, namely the edge of wheat fields adjacent to standing stubble and volunteer wheat in or near stubble, the result will undoubtedly be a great decrease in the amount of infestation during the succeeding seasons.

NOTES ON THE BRONZE APPLE-TREE WEEVIL[1]

By G. F. MOZNETTE,[2] *Entomological Inspector, Bureau of Entomology, United States Department of Agriculture*

INTRODUCTION

The bronze apple-tree weevil, *Magdalis ænescens* Lec., is prevalent throughout the Willamette Valley in Oregon. This is true particularly in vicinities where trees which this species attacks have been neglected or for some cause are devitalized and gradually dying. This species has not been observed attacking healthy trees, but where a tree is slowly dying from some cause, this species generally attacks it and hastens the death.

HISTORY AND DISTRIBUTION OF THE SPECIES

The species was first described by Dr. LeConte[3] in 1876 from specimens presented him by Mr. Ulke collected in Oregon. In 1898 Dr. James Fletcher[4] reported having received specimens from apple boughs containing the larvæ of this insect from Victoria and Nanaimo, British Columbia, and proposed the name bronze apple-tree weevil for it. In 1900 Dr. F. H. Chittenden[5] published an account of this insect from investigations made of material received from the state of Washington where the insect was thought associated with the "Black Spot" or canker, a fungus disease caused by *Macrophoma curvispora* Peck. This report also contains biological notes by Prof. C. V. Piper then connected with the Agricultural Experiment Station at Pullman, Washington, and he states that the insect injury was apparently secondary to the fungus disease mentioned above. In 1911 H. F. Wilson published notes on this species stating further occurrence in the state of Oregon.

Records of this species by Dr. Chittenden shows the distribution to be Sunnydale, Puyallup, Tracyton, Vancouver, Sedro and Woolley in Washington; Salem, Hood River, and Corvallis in Oregon; Victoria, Nanaimo and Gabriola Islands in British Columbia. In addition to the above localities the writer wishes to add the following: Liberty, Eddyville, Portland, Turner and McMinnville in Oregon.

HOST PLANTS

In no case has the writer observed this species infesting healthy trees. The trees are injured in some way, either due to winter killing or to the

[1] Published by permission of the Secretary of Agriculture.

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[3] Proc. Amer. Phil. Soc., Vol. XV, p. 192.

[4] Rept. of Ent. and Bot., 1898, Canada.

[5] Bul. 22, Bureau of Entomology, p. 36 (Misc. Results).

attacks of some disease; any general deteriorated condition of the trees promotes the attacks of the weevils. The species was taken from apple, Cratægus and Italian prune trees. During the early part of 1916 while at McMinnville, Oregon, this species was observed in numbers in Italian prune wood. This wood had been sawed from orchard trees killed apparently through the attacks of the peach and prune root borer, *Aegeria opalescens* Edw., a destructive insect to peaches and Italian prunes in that section of Oregon. As the trees were grubbed out during the winter, they were apparently infested while in the orchard, the weevils developing in the wood after it was sawed.

The species was found in many apple trees in the vicinity of Corvallis, Oregon, but only in dead or nearly dead areas of such trees. It has not been found by the writer to be associated with any canker but later found that the attacks of the weevils were only secondary.

Notes on Seasonal History and Habits

On April 15, 1916, the writer obtained several large apple limbs from a tree located near Corvallis, Oregon, growing in the center of a stream. The tree was greatly devitalized and only the more seemingly healthy areas bordered with the dead wood showed the presence of the insect. In these particular limbs a few of the areas could be found containing egg punctures of the previous season. Upon examination the portion underneath the bark and next to the wood was found furrowed with channels running in every direction (Plate 18, figs. 4, 5) and revealed the presence of many pupæ and larvæ of this species. Some were just transforming to adults and changing color. The beetles (Plate 18, fig. 1) on emerging are at first a very light brown changing on exposure to a blackish bronze color. The description of the adult by Dr. LeConte is as follows:

> Elongate, black bronzed, slightly pubescent, head, beak and prothorax densely finely punctured, the last longer than wide, rounded on the sides, which are serrate in front; hind angles small, prominent, base bisinuate, disc subcarinate in front of the middle. Elytra obliquely impressed behind the base, and also behind the middle; striæ composed of not very large punctures, interspaces finely rugose. Mesosternum not protuberant; thighs acutely toothed, claws distinctly toothed near the base. Length, 3.7–5.6 mm.; .15–.22 inch.

On April 15, 1916, very few larvæ were to be found and no doubt most of the larvæ had transformed from the first of April until about the tenth. Seasonally this will vary considerably with the weather conditions.

The larva (Plate 18, fig. 3) before pupation excavates an oval cell between the bark and wood at the end of the burrow. It is legless, white in color and the body is considerably wrinkled. The body is larger in the prothoracic region and in this way differs somewhat from the ordinary Curculionid type of larva. The mouth parts are brown and small.

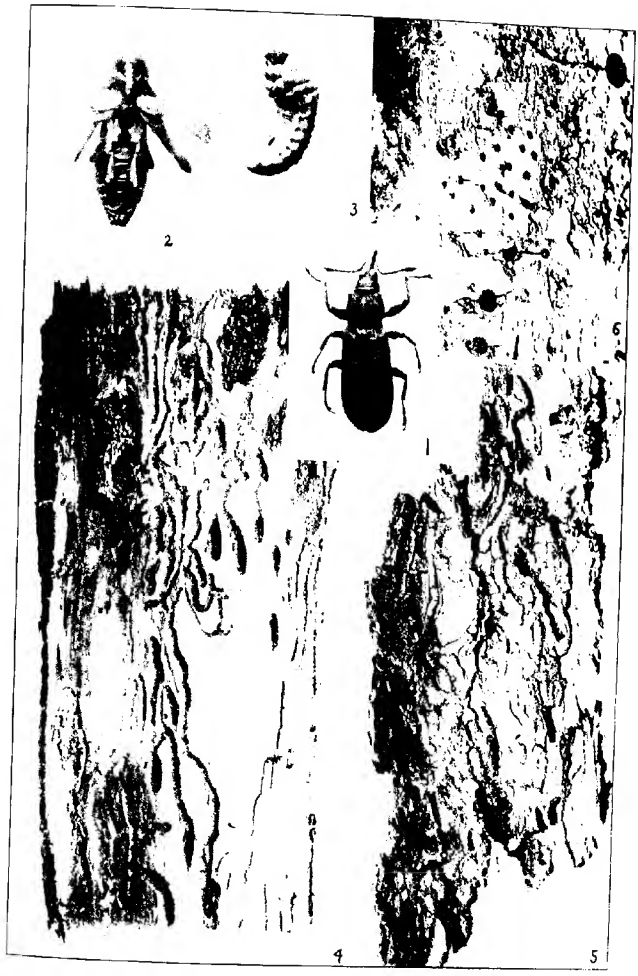
Before pupating the larva lines the oval cavity (Plate 18, fig. 4) with frass in which it pupates. When the larva transforms into the pupal stage (Plate 18, fig. 2) one may see the resemblance which it has to the adult beetle. The head and snout are bent down over the thorax along the ventral side of the body and is white in color. The pupal stage lasts approximately five days, depending on the weather conditions. On April 24, 1916, many adults had emerged from the pupal stage and were feeding on the foliage. On the foliage they eat out peculiar round holes about the size of the end of the rostrum, some leaves appeared riddled with these small circular cut places. The species was observed to feed particularly on the upper surface of the leaves.

On the morning of April 25, 1916, observed several females in the act of depositing eggs in the bark. For egg deposition the females do not ordinarily prefer the smooth bark but instead seek the more roughened areas. The rostrum is used to burrow the cavities to receive the eggs. The rostrum being curved the female is able to cut out a sort of chamber underneath the bark by turning the beak around. After the excavation is completed the female turns about and deposits the egg. The egg is very small, a little over $\frac{1}{2}$ mm. in length, is yellow, shining and globular in shape. After depositing the egg the female forces it into the cavity by means of the rostrum and usually the cavity is sealed with frass. A number of cavities may be found arranged in a circular mass (Plate 18, fig. 6). The number of egg cavities in one mass was observed to range from four to twenty-one. According to Prof. C. V. Piper the different egg cavities in each group are burrowed at different times; at least in all the cases observed by him the beetle went away after digging one cavity and laying her egg therein. The writer's observations show that a female burrowed a maximum of four cavities in one place at a time and then left.

The adults do not live very long after egg deposition and in the cages it was observed that the beetles showed a disposition to kill each other. The eggs which were deposited on April 26, 1916, had all hatched on May 14 and 15, 1916. The larvæ upon emergence immediately burrow in any direction in the bark close to the wood (Plate 18, fig. 4) or just on the surface including a little of the wood as they tunnel. The burrow is at first very small, measuring a half millimeter and when completed about two millimeters. The larvæ live over winter feeding on the bark and on the surface of the wood next to the bark, transforming again in the early part of April. The length of the larval stage is approximately ten to eleven months depending on the weather conditions in the spring.

Parasites

The large limbs which were obtained on April 15, 1916, were found on examination to contain numerous specimens which were parasitized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The number of parasitized individuals averaged 50 per cent. There were two species of parasites which were from the larvæ and pupæ. These were determined for me by Mr. H. S. Smith as a (Chalcidoidea) *Tetrastichus* sp. and a (Braconid) *Calyptus* sp. The primary parasite was not determined and it is possible one is a hyperparasite. The writer also found quite a number of larvæ of some Coleopterous insect which resembled a Dermestid.

Explanation of Plate 18

Fig. 1, the adult weevil.

Fig. 2, the pupa.

Fig. 3, the larva or grub.

Fig. 4, section of apple limb with bark removed showing channels of larvæ and pupal cells.

Fig. 5, section of bark removed from limb showing channels of larvæ and pupal cells.

Fig. 6, section of bark showing egg punctures or cavities where eggs are laid and the emergence holes of the adults.

THE BENEFICIAL ACTION OF LIME IN LIME SULFUR AND LEAD ARSENATE COMBINATION SPRAY

By R. H. Robinson, *Associate Chemist, Oregon Experiment Station, Corvallis, Ore.*

It is a prevalent custom among horticulturists throughout the country to use combination sprays, that is, mix two spray materials and make the application as a unit whereby the extra expense of making two separate sprayings is saved. If, however, two sprays are so combined that a chemical reaction occurs in which their peculiar insecticidal or fungicidal properties are destroyed or some product of the reaction is formed, that would cause burning of foliage or other injury, the practice in that case should be discouraged. It is probable that where combination sprays have given unfavorable or even harmful results and the cause attributed to poor quality of original materials used, that the actual reason may be due to products formed following chemical reaction between the two sprays combined, when the insecticidal properties are thus destroyed. In many such instances the deleterious action might be partially or entirely prevented by the addition of some inert substance that would retard chemical changes.

We have, by mixing lime sulfur and lead arsenate, one of the most important combination sprays now generally employed. It is plainly evident that both of these sprays immediately begin to change in appearance and a dark precipitate settles out after they are mixed. Owing to the chemical action that occurs in which the insecticidal properties of this combination spray is destroyed to a certain extent, means of overcoming

this difficulty is worthy of especial consideration. As shown by Tartar and Robinson[1] and later by McDonnell and Smith[2] and also by G. E. Smith,[3] there are two lead arsenates, namely, lead hydrogen or acid arsenate, and basic or neutral lead arsenate, that are easily prepared. Both of these are manufactured commercially and sold on the market chiefly for spraying purposes. Since perhaps more than 95 per cent of the lead arsenate sold is the lead hydrogen arsenate, this is the type generally used in combination sprays. When combined with lime sulfur it was observed that the residue from the mixture of the lead hydrogen arsenate was much darker than that obtained with the neutral arsenate, indicating greater decomposition. Consequently a study was made of the changes that occurred when lime sulfur, diluted to summer spraying strength, was mixed with lead hydrogen arsenate and with basic lead arsenate.

Lime sulfur having a specific gravity of 1.259 was diluted at the rate of 1 gallon to 30 gallons of water. To each of several 1000 cc. portions of this dilute lime sulfur solution, 4.8 grams of the different arsenates mentioned were added. The mixture was agitated occasionally during 14 hours, allowed to settle, and the clear lime sulfur siphoned off from the lead arsenate residue. The residue was then transferred to a filter, washed thoroughly with cold water and dried at 60 degrees C. The following table shows the important changes that occurred in the lime sulfur, diluted for summer spraying, and mixed with lead hydrogen and basic arsenate.

TABLE I. COMPOSITION OF LIME SULFUR BEFORE AND AFTER ADDITION OF HYDROGEN AND BASIC LEAD ARSENATE

	Lime sulfur only	Lime sulfur and lead hydrogen arsenate, grams per 1000 cc.	Lime sulfur and basic lead arsenate
Lime, CaO	4.2280	3.1880	4.0880
Sulfur, S	8.8004	5.8367	8.7496
Arsenic oxide, As_2O_5	None	.0740	.0014
Lead oxide, PbO	None	None	None

The above results indicate that there is considerable reaction between lime sulfur and lead hydrogen arsenate while the basic lead arsenate caused only a slight change in the lime sulfur. Calculated from the original amount of lead hydrogen arsenate used, over 5 per

[1] Tartar, H. V., and Robinson, R. H. The Arsenates of Lead, Journal of American Chem. Society, Vol. 36, Sept., 1914.

[2] McDonnell, C. C., and Smith, C. M. The Arsenates of Lead, Journal of American Chem. Society, Vol. 38, Oct., 1916.

[3] Smith, G. E. Lead Arsenates, Journal of American Chem. Society, Vol. 38, Oct., 1916.

cent of the arsenic was found in a soluble form thus increasing the tendency to cause burning of foliage and other injury. Furthermore the decrease in the sulfur content indicates excessive loss of that active element. The total polysulfid content was reduced from 8.8004 grams to 5.8367 grams or over 35 per cent. In other words, by mixing lead hydrogen arsenate and summer strength lime sulfur the efficiency of the latter is decreased more than 35 per cent while severe burning of foliage may occur owing to the presence of arsenic as a soluble salt.

The changes that occur in the composition of the lead hydrogen arsenate mixed with the lime sulfur as shown by analyses of the lead arsenate residue likewise emphasize the need for adding some inert material that will diminish the chemical reaction. Table II gives the analyses of both types of arsenates before and after mixing with lime sulfur and treated as described above:

TABLE II. ANALYSES OF LEAD HYDROGEN AND BASIC ARSENATE BEFORE AND AFTER MIXING WITH LIME SULFUR

	Lead hydrogen arsenate		Basic lead arsenate	
	Before mixing	After mixing	Before mixing	After mixing
Lead oxide, PbO	63.86%	34.83%	74.70%	72.13%
Arsenic oxide, As_2O_5	32.90%	18.11%	23.41%	22.71%
Lime, CaO	——	12.97%	——	2.42%
Lead sulfid, PbS	——	25.25%	——	.14%

These results substantiate those given in Table I. Both sulfur and lime have been removed from the lime sulfur in the reaction and the lead from the lead arsenate to form sulfide of lead. From the analysis the decrease in the quality of the insecticide is self-evident.

Although the foregoing results show that the basic lead arsenate may be advantageously mixed with lime sulfur, since it is not available, the hydrogen arsenate must be used. Hence the importance of adding some inert material in order to prevent, as much as possible, the devitalizing reaction. During investigations on the calcium arsenate by the writer[1] it was observed that slaked lime, $Ca(OH)_2$, prevented almost entirely any decomposition of both calcium arsenate and lime sulfur when mixed. Consequently it was thought that lime might have a similar effect when used with lime sulfur and lead arsenate combination spray and the reaction tend toward the formation of the basic lead arsenate according to the equation:

$$3\ PbH\ AsO_4 + Ca(OH)_2 = Pb_3(AsO_4)_2 + CaHAsO_4 + 2\ H_2O$$

To this end a study was made using both pure material, prepared in the laboratory, and commercial samples. The lime was obtained by

[1] Robinson, R. H. The Calcium Arsenates, Jour. of Agri. Res., Vol. 13, Apr. 29, 1913.

igniting C.P. calcium carbonate until all carbon dioxide was driven off; lime sulfur was made from recrystallized sulfur and from lime obtained as described above; lead hydrogen arsenate was prepared by the method outlined by Robinson and Tartar.[1] The commercial products used were standard brands found on the market.

The outline of procedure was as follows: The lime sulfur, both laboratory prepared sample and commercial brands was brought to a density of 1.262 or 30 degrees Baume and diluted 1 part to 40 parts of water or summer strength. After slaking with a small amount of water, lime was added at the rate of 10 pounds to 100 gallons. Finally, lead hydrogen arsenate was added at the rate of 2 pounds to 100 gallons or 4.8 grams to 1000 cc., the quantity used in the experiment. In this manner, triplicate portions of each brand of lime sulfur taken were prepared. The mixtures were then shaken occasionally during three hours and after filtration, determinations for soluble arsenic were made. Table III gives the per cent of arsenic found:

TABLE III. PER CENT OF SOLUBLE ARSENIC IN LIME SULFUR SOLUTION FROM COMBINATION SPRAY, TREATED AND UNTREATED WITH LIME

	Without lime	With lime
Lab. prepared lime sulfur and lead arsenate	12.90%	0
Commercial sample No. 1, lime sulfur and lead arsenate	12.20%	0
Commercial sample No. 2, lime sulfur and lead arsenate	12.90%	0

It is obvious from these results that the presence of free lime prevents arsenic from going into solution as a soluble salt. On the other hand where no lime was added a usual high per cent of soluble arsenic was found indicating that over 12 per cent of the lead hydrogen arsenate was decomposed, decreasing its efficiency accordingly. Observation on the changes that occurred during the reaction showed that those samples treated with lime slowly turned to a gray color similar to the basic lead arsenate and lime sulfur mixture where the amount of chemical changes was negligible, while those untreated immediately turned black, indicating the breaking down of both lime sulfur and lead arsenate and the formation of lead sulfid.

Change in the polysulfid content of the lime sulfur was likewise studied. The total sulfid content was first determined in the diluted lime sulfur solution, and, after treatment as described above, again determined after shaking at intervals during three hours and again after two days. The table gives the grams contained in 1000 cc. of lime sulfur and lead arsenate mixture.

[1] Robinson, R. H., and Tartar, H. V. The Arsenates of Lead, Ore. Exp. Sta. Bul. 128, 1915.

TABLE IV. AMOUNT OF POLYSULFIDS IN LIME SULFUR TREATED AND UNTREATED COMBINATION SPRAY

	After 3 hrs.	After 2 days
Lime sulfur only	4.360 gms.	4.360 gms.
Lime sulfur and lead arsenate	1.892 "	None "
Lime sulfur and lead arsenate and lime	4.240 "	3.010 "

Here again the value of adding lime to lime sulfur previous to combining with lead hydrogen arsenate is emphasized. The polysulfid content of the combination spray that had been treated with lime had decreased only a negligible amount while the untreated showed a loss of almost 50 per cent of its fungicidal and insecticidal properties.

Attention is further called to chemical changes that had continued during two days: Where lime had been previously added to the combination spray over 75 per cent of the lime sulfur remained unchanged and as efficient as ever for spraying purposes. Where no lime had been added all polysulfid sulfur had been transformed into sulfid of lead or to thiosulfate. In this form the spray is practically valueless as its peculiar properties are destroyed.

CONCLUSIONS

The data herein reported indicate that there is a pronounced detrimental chemical reaction between lime sulfur and lead hydrogen arsenate when mixed for a combination spray.

The addition of lime at the rate of about ten pounds to 100 gallons of lime sulfur, previous to adding the lead arsenate, prevents to a certain extent this reaction.

THE HOUGHTON GOOSEBERRY APHIS

By A. C. BAKER, *Entomologist, Deciduous Fruit Insect Investigations, U. S. Bureau of Entomology*

In 1906 James Troop[1] described under the name of *Aphis houghtonensis* a species of aphid injurious to gooseberries in Indianapolis. Troop's specimens were taken during 1904 and later during 1905. Specimens were sent to Washington and were mounted and studied by Mr. Pergande. The first sending was received on July 25, 1904. On this material Pergande made the following note: "The apterous females are pale dirty yellowish, the abdomen marked with very few dark or bluish-green, scattered spots; the eyes dark brown; the antennæ yellowish with apex of the 5th, the 6th and the spur dusky; nec-

[1] Ent. News Phila., Vol. 17, p. 59–60.

taries and tail of color of body; no lateral tubercles on body; hairs of antennæ, head, body and legs capitate; nectaries rather short."

Other sendings were received from Troop and recorded by Pergande on the following dates: August 1, 1904, August 25, 1904, October 6, 1904, May 15, 1905, and May 22, 1905. Under this last date Pergande made some color notes on the live alate form as follows: "The abdomen of the migrant is of a light glassy, bluish-green color, the head and thorax brownish-yellow with the thoracic lobes somewhat darker."

Three other records of the species have been made. Davis[1] (1910) recorded the species from Illinois and figured the sensory characters of the alate form, while Davidson[2] (1914) recorded the species doubtfully from California. These two workers have since written that the insects described by them were not this species. The third record is that of Headlee[3] (1916).

On May 12, 1916, Mr. F. L. Simanton reported an aphis injurious to the Houghton gooseberries at Benton Harbor, Mich. Specimens of this species were submitted on May 22nd and proved to be *houghtonensis*. Mr. Ackerman forwarded young stem mothers from this same locality in the spring of 1917 and from these young rearing experiments were begun.

Eggs

The specimens received were upon small infested shoots and indicated that the eggs, the shells of which were present, are laid upon the bark under the loose folds which extend down the twig. Later twigs were received with many eggs still unhatched and these showed that the usual position is under the loose bark though eggs are also laid about the bases of the buds and occasionally upon the thorns. The eggs hatch about the middle of April.

Stem Mother

As soon as the young stem mothers are hatched they wander to the young opening leaves to feed and place themselves either on the under surface of the leaves or upon the petioles. The leaves immediately begin to curl and before long entirely enclose the stem mothers and any young they may have produced. In our experiments a young stem mother which began feeding on a leaf May 1 was by the 10th entirely enclosed by the rolled up leaf. By this time she had produced several young but only one remained on the curled leaf with her, the others migrating to new leaves.

[1] Jr. Econ. Ent., Vol. III, p. 485.
[2] Jr. Econ. Ent., Vol. VII, p. 132.
[3] Rept. of the Entomologist of New Jersey for 1915.

Alate viviparous Form

It is interesting to note that this form occurred in every generation in which specimens were reared from the second onward. Part of the offspring of the stem mothers thus became winged. All specimens of this form which were placed upon gooseberry in the experiments died without reproducing and this would seem to indicate that an alternate host is necessary, at least to certain individuals.

Description

Fifth Instar (adult).—Color dark green, head and thorax brownish; eyes dark brown. Antennæ, distal part of femora and tibiæ and the tarsi brownish. Wing veins margined with brown. Cornicles pale.

Length from vertex to tip of cauda 1.44 mm. Forewing 3.2 mm. long, 0.88 mm. broad at the stigma. Length of the antennal segments and cornicles is given in the following table. There is considerable variation in the size of the specimens and the number of sensoria and this is indicated by the variations in the table. Vertex and antennal segments armed with a number of capitate hairs; similar ones also present on the legs and abdomen, and a few upon the thorax. Cornicles flanged and distinctly imbricated, slightly swollen in their distal portion. Cauda constricted near base, minutelyse tose and armed usually with five prominent hairs. Slight antennal tubercles are present on the head.

Table of Measurements of the Antennæ of the Alate Form

Seg. III	No. of sen.	Seg. IV	No. of sen.	Seg. V	No. of sen.	Seg. VI base	Seg. VI unguis	
0.384	23	0.176	7	0.16	4	0.064	0.416	0.192
0.384	24	0.176	4	0.16	4	0.064	0.432	0.192
0.4	20	0.224	5	0.224	2	0.08	0.512	0.224
0.4	22	0.24	6	0.224	1	0.08	0.496	0.24
0.464	23	0.224	2	0.224	1	0.08	0.624	0.192
0.448	22	0.272	3	0.256	3	0.08	0.608	0.192
0.48	19	0.288	5	0.272	2	0.096	0.672	0.192
0.448	21	0.256	6	0.272	2	0.08	0.608	0.208
0.48	17	0.288	5	0.272	1	0.096	0.585	0.192
0.480	27	0.272	6	0.256	1	0.08	0.56	0.208

Intermediate

One intermediate was available for study. This was taken in the field by Mr. Simanton. We are unable to give, therefore, anything in regard to its occurrence or reproductive activities.

Description

Color similar to that of the apterous form. Length from vertex to tip of cauda 1.296 mm. Width, 0.688 mm. Form flat with the thorax broad giving a shoulder effect not found in the apterous form but apparently without distinct wing rudiments. Antennæ as follows: Segment III, 0.384 mm. and armed with 15 sensoria; IV, 0.208 mm. and without sensoria; V, 0.208 mm. and with only the distal sensorium; VI (0.08 mm.+0.432 mm.). Cornicle, 0.224 mm. Cauda, 0.192 mm. Beak extending beyond the second pair of coxæ. Body armed with the usual hairs.

Summer Apterous Form

This form first appeared in our experiments on May 9th when young were produced by adult stem mothers. They attacked the leaves in the same manner as did the stem mothers and caused many of them to roll very tightly so that great difficulty was experienced in examining the insects. These forms also fed on the tender growing shoots and produced the beginnings even in the second generation of that distortion so conspicuous in the field.

Description

First Instar.—General color uniform pale greenish due to the body contents. The skins are transparent with the exception of the tarsi, the tips of the distal segments of the antennæ and the tip of the labium. Antennæ of four segments with the following measurements: Segments I and II about 0.032 mm. long and about as thick as long; segment III, 0.096 mm.; segment IV (0.032+0.096 mm.). Segment III is armed with two stout spines near the distal sensorium and segment IV has one or two similar ones. The unguis is imbricated. Labium about as long as the antennæ.

Second Instar.—Very similar in general appearance to the insects of the last instar. The antennæ, however, possibly show a little more dusky than those of the previous stage. Measurements as follows: Segment I, 0.048 mm. long and nearly as wide; segment II, 0.032 mm. long and of about the same width; segment III, 0.16 mm.; IV (0.048+0.16 mm.). Segment III with a number of stiff hairs, similar hairs rather prominent also on the first two segments. Cornicles very short and broad.

Third Instar.—General appearance very similar to that of the last instar. Measurements as follows: Antennal segment I, 0.64 mm. long; segment II, 0.048 mm.; segment III, 0.192 mm.; segment IV, 0.096 mm.; segment V (0.048+0.224 mm.). The segments are armed in a manner similar to those of the last instar. In some cases segment III is divided.

Fourth Instar.—Color as in previous instars. Measurements as follows: Antennal segment III, 0.16 mm.; segment IV, 0.096 mm.; segment V, 0.096 mm.; segment VI (0.048+0.256 mm.). Segments armed with hairs which are somewhat stouter than in the previous instars. Otherwise individuals of this instar resemble those of the previous instar.

Fifth Instar (adult).—Color yellowish-green maculated with a darker green upon the abdomen, eyes brown. Sixth segment of antennæ and the distal extremities of V, IV, and III dusky, cauda and cornicles concolorous with the abdomen.

Length from vertex to tip of cauda 1.44 mm., width across abdomen 0.768 mm. Antennæ as follows: Segment III, 0.384 mm., armed with about ten subcircular sensoria in a row on the basal three-fourths of the segment, 12–14 capitate hairs also present; IV, 0.224 mm., without sensoria but with 4 or 5 capitate hairs; V, 0.208 mm., with a very prominent distal sensorium and several capitate hairs; VI (0.08 +0.43 mm.), imbricated and armed with hairs on the base. Vertex with a median projection and armed with capitate hairs which are also present on the slight antennal tubercles. Body covered with similar hairs. Cornicles 0.224 mm., imbricated, almost cylindrical, not swollen as much as in the alate form. Cauda similar to that of the alate form but somewhat broader.

Sexes

The sexes which have not before been described appear upon the bushes in September and October and eggs are laid (in confinement) as early as the first week in October. Both sexes are apterous, the males being very small. Descriptions of the sexes follow:

Male

Fifth Instar (adult).—In general color the male does not differ greatly from the other apterous forms though it is darker, the antennæ being quite dusky. Average measurements are as follows: Antennal segment I, 0.064 mm.; II, 0.048 mm.; III, 0.256 mm.; IV, 0.16 mm.; V, 0.144 mm.; VI (0.048+0.256 mm.). The segments are armed with short, rather stout hairs and with small circular sensoria. These last number about as follows: Segment III with 14 or 15 of uneven size and irregularly placed over the segment, IV with usually 6, V with about 5. In some cases segments III and IV are united and measure about 0.356 mm. and possess about 22 irregularly placed sensoria. Cornicles short, not more than 0.096 mm., subcylindrical, slightly swollen near their distal extremities. Hind tibiæ about 0.624 mm. Cauda 0.096 mm. Length from vertex to tip of cauda 0.96 mm.

Ovipara

Fifth Instar (adult).—General color very similar to that of the viviparous form, the one or two large eggs within showing very distinctly through the abdominal wall. Average measurements as follows: Antennal segment III, 0.176 mm.; IV, 0.112 mm.; V, 0.112 mm.; VI (0.064+0.272 mm.). The antennæ are without secondary sensoria but the segments are armed with short rather stout spine-like hairs. Cornicles 0.144 mm., almost cylindrical, distinctly imbricated, possessing, however, quite a marked flange and a considerable constriction just proximad of it which gives the cornicle the appearance of being slightly swollen. Cauda about 0.128 mm. Hind tibia not distinctly swollen but armed with a small group of sensoria on its proximal quarter, length of tibia 0.544 mm. Length from vertex to tip of cauda about 1 mm.

THE LIFE HISTORY AND EARLY STAGES OF MACROPSIS VIRESCENS VAR. GRAMINEA (FABR.),[1] A POPLAR LEAF HOPPER IN NEW JERSEY (HOM.)

By Harry B. Weiss and Edgar L. Dickerson, *New Brunswick, N. J.*

The following notes are the results of observations made at various times during the past several years on *Macropsis virescens* var. *graminea* which was fairly abundant on Lombardy poplars growing in a nursery at Irvington, N. J.

The species overwinters in the egg stage, the eggs being found in two year old wood, usually in the neighborhood of the buds near the end of the growth, although some eggs were found in the twig tissue between the sets of buds. The eggs are inserted singly on their sides just beneath the bark tissue and the bark over the egg is raised showing

[1] Identified by E. P. Van Duzee.

the contour in a somewhat irregular fashion. The tissue around the egg is somewhat discolored and brownish but there is practically no cracking of the bark over the egg. There is, however, a slight crack in the bark where the egg is inserted. The eggs were found in all positions and aside from the fact that each egg is inserted resting on its side, there appears to be no uniformity in deposition.

Hatching takes place during the first week in May at a time when the leaves are small and by the last few days in May and the first part of June, the first adults appear. The bulk of the adults, however, appears about the middle of June and from then on until the middle of July and later they can be found scattered over the trees. Egg laying takes place during the last of June and first part of July. Females collected on July 2 and dissected were found to contain 8, 7, 3, 8 and 2 eggs each.

There are five nymphal stages and the combined time necessary for them to mature is about one month. The early stages are found on the young unfolding leaves and leaf petioles, usually at the bases with their heads downward although some can be noted in the reverse position, sometimes three or four on a single leaf. As they become older they disperse and move to the stems where they rest in similar positions in the axils of the leaves or occasionally on the petioles.

Practically all of the nymphal feeding takes place at such localities and only rarely are the nymphs found on the leaves. Resting on the stems as they do, they closely resemble buds. The cast skins are found fastened securely by the beaks to the petioles and occasionally on the upper and lower leaf surfaces, indicating where moulting takes place. As a rule the nymphs are more or less sluggish and can be captured readily. The adults are more active especially on bright, sunny days but they also have the habit of resting mostly on the twigs.

Egg.—Length, 1.1 mm.; greatest width, 0.19 mm. Translucent, subcylindrical, elongate, curved, tapering to both ends which are rounded, basal end more broadly rounded than apical end.

First Nymphal Stage.—Length, 1.2 mm.; width of head, including eyes, 0.35 mm. Elongate-elliptical; tapering gradually to posterior end; front subtruncate or broadly rounded; dorsal surface sloping upward from lateral margin and forming a median ridge. Light brown on dorsal and lateral surfaces; dorsal surface of this and remaining stages specked with black; legs light brown except at coxal-femur joint. Eyes lateral, prominent, consisting of a number of ommatidia. Antennæ extending beyond posterior margin of prothorax, two basal segments quadrate, subequal, apical segment two and one-half to three times as long as basal segments combined, tapering gradually to tip. A pair of minute spines on top and vertex of head and several spines below on front and base of rostrum; all of these spines anteriorly directed. Two minute, median pairs of spines on prothorax, one anteriorly and the other posteriorly directed (one pair behind the other); on remaining thoracic segments, a pair of posteriorly directed, median, dorsal, slightly curved spines with united base.

Each abdominal segment bears a pair of posteriorly directed, median, dorsal spines with united base. Minute, posteriorly directed spine arising from lateral margin of each abdominal segment; one or more longitudinal rows of fine spines on abdomen between median-dorsal and lateral rows; few, minute spine-like hairs on posterior end. Tibia and tarsus bear number of minute, spine-like hairs. Ventral surface light; rostrum extending to beyond bases of second pair of legs.

SECOND NYMPHAL STAGE.—Length, 1.6 mm.; width of head, including eyes, 0.5 mm. Somewhat similar to preceding stage in color, shape and armature. Shape slightly broader. Color light brown with darker bands extending longitudinally from anterior to posterior end between lateral margin and dorsal ridge. Armature more pronounced, similar to that of preceding stage except for an additional, smaller spine and indications of another on the lateral margins of the abdominal segments anterior to spine noted in first nymphal stage. Ventral surface light; coxa and femur lighter; rostrum similar to that of first stage, lancets on most specimens extending beyond tip of rostrum.

THIRD NYMPHAL STAGE.—Length, 2.2 mm.; width of head, including eyes, 0.75 mm. Somewhat similar to second stage, slightly broader, especially at posterior part of thorax. Lateral margins of thoracic segments, especially that of mesothorax slightly expanded. Lateral, posterior margins of mesothorax partially cover those of metathorax. Dorsal thoracic surface tending to become rounded. Abdominal segments maintaining median ridge, especially in posterior portion where it is quite acute. Color darker, broad bands noted in preceding stage prominent in some specimens and in others so suffused as to leave lighter shade along median, dorsal ridge. Eyes lateral, globular, prominent. Armature somewhat similar to that of preceding stage, all spines more prominent; hair-like spines on legs more prominent; spines on outer surface of tibia forming rows along anterior and posterior margins. Ventral surface light; legs similar in color to brown of dorsal surface; rostrum similar to that of preceding stage.

FOURTH NYMPHAL STAGE.—Length, 3.2 mm.; width of head, including eyes, 0.89 mm. Similar in color and shape to that of third stage except for the head which is shorter, being four to five times as broad as long. Spines on head less prominent. Sides of meso- and metathorax extending posteriorly so that lateral lobes of mesothorax cover much of metathoracic lobes which extend into the second abdominal segment and partially cover sides. Several spines on lateral margin of mesothoracic lobes. Minute spines along lateral margin of abdomen increasing in number. Median ridge decidedly acute on abdomen, more so toward posterior end. Otherwise similar to third stage nymph.

FIFTH NYMPHAL STAGE.—Length, 4.2 mm.; width of head, including eyes, 1.3 mm. Elongate-elliptical. Head, dorsal surface of thorax and abdomen, tibia and tarsus reddish-brown (some specimens lighter with two longitudinal bands prominent); posterior parts of body darker in some specimens. Eyes more prominent, antennæ similar to those of preceding stages. Wing pads of mesothorax extend posteriorly and cover outer portion of those of metathorax. Both pairs extend to lateral margin of second abdominal segment. Dorsal median ridge prominent and darker on top. Armature similar to that of preceding stage, dorsal, median spines less prominent. Number of minute spinelike points on ventral surface. Rostrum similar to that of fourth stage. Circle of hairs bordering anal opening. Sexes distinguishable in this stage. Otherwise similar to preceding stage.

ADULT.—*Macropsis virescens* var. *graminea* Fabr. The following is the original description from Ent. Syst. Suppl., 1798, p. 521. "Cicada graminea. viridis capite

subeleuto: puncto apicis atro. Habitat in Italia Dr. Allioni. Statura omnino C. prasinæ at paullo minor et distincta. Corpus totum viride puncto solo atro in apice capitis postice parum eleuati."

The following brief description of this species is given by Osborn (Bul. 238, Me. Agric. Exp. Sta., 1915): "Approaching *viridis* but smaller and more slender with a conspicuous black spot on the base of the hind tibia. Female, length, 5 mm.; width, 1.25 mm. Male, length, 4.4 mm.; width, 1 mm. Vertex very short, strongly angled, rounded at extreme tip; pronotum sharply angled in front, sloping to front and sides, concave behind or with hind border subangularly excavated. Color of female light green, elytra becoming transparent toward tip; eyes brown; a black spot at base of tibia; tarsi yellowish-brown; male slightly darker than female, the elytra in one specimen faintly, in the other distinctly smoky; scutellum with a black triangle in lateral angles, eyes and tarsi as in female and the black spot on base of hind tibia distinct." He further states that "this species is apparently identical with the European form and has been recorded for America but once in my report (20th N. Y.). The New York specimens were referred to the variety *graminea* in which there is a black spot at tip of vertex."

So far there are only two recorded localities for this species in America. Osborn (20th Rept. State Ent. N. Y., 1904, p. 505) states, "two specimens, females collected on willow at Fitch Point, near the Fitch Home, Salem, N. Y., August 14, 1904." In the Maine bulletin he records "three specimens were taken in sweeping on a clump of cornus July 22 near Orono on Dr. Patch's farm. No nymphs were taken and it is unsafe to regard cornus as food plant as there were willows in vicinity."

Our material was found abundantly on Lombardy poplar in a nursery at Irvington (near Newark), N. J. Specimens of what was apparently this species were also found on elm in a nursery at Rutherford, N. J. There seems little doubt that this is as suggested by Osborn, a European species. Its introduction could readily be accounted for by the fact that the insect overwinters in the egg stage in the twigs.

Van Duzee in his catalogue of Hemiptera gives the following references:

Fabricius, Ent. Syst. Suppl., p. 521, 1798 *Cicada.*
Fabricius, Syst. Rhyng., p. 77, 1803 *Cicada.*
Germar, Mag. d. Ent., IV, p. 81, 1821 *Jassus.*
Fieber, Verh. Zool. Bot. Ger. Wien., XVIII, p. 459, 1868 *Pediopsis.*
Oshanin, Vers. Palae. Hemip., II, p. 73, 1906 *Pediopsis.*
Osborn, 20th Rept. N. Y. St. Ent., p. 505, 1905 *Pediopsis.*
Horvath, Ann. Mus. Natl. Hung., VI, p. 6, 1908 *Pediopsis.*
Osborn, Me. Agr. Exp. Sta. Bul. 238, p. 90, 1915 *Pediopsis.*
Localities, N. Y., Me., Europe.

LACE BUG ON HAWTHORN, CORYTHUCHA BELLULA GIBSON[1]

(TINGIDIDÆ, HEMIPTERA)

By WALTER H. WELLHOUSE, *Ithaca, N. Y.*

This tingid was originally found June 18, 1917, four miles southeast of Tiffin, Ohio, on four or five Cratægus trees by Carl J. Drake and the adult was described March, 1918, by E. H. Gibson (Trans. Amer. Ent. Soc. 44: 69-104). Professor Drake informs the writer that he found one of these trees very badly infested with thousands of specimens feeding on it and that he found eggs, nymphs and adults on this same tree in August, 1918. There is no other record of this species having been found. The writer has observed it during the past year in several localities about Ithaca.

HOSTS

It seems to confine its attack to those species of Cratægus that have an abundance of pubescence along the veins on the lower sides of the leaves. I have found it breeding in abundance on *Cratægus neofluvialis* and to some extent on *C. albicans* and *C. punctata*. Those species with smooth leaves, such as *C. pruinosa*, *C. crus-galli* and *C. oxyacantha*, even when their branches were intermingled with those of trees which were badly infested, revealed no nymphs or eggs.

INJURY

In a large thicket of *Cratægus neofluvialis* trees near the Cornell University campus the leaves were so discolored by the end of July that they attracted the attention several hundred yards away. By the middle of August the leaves were falling and the branches were bare by September 1. No fruit matured on these trees. A few scattered trees of this species in other directions from the city were also badly infested. Individual trees of *Cratægus albicans* and *C. punctata* showed an occasional branch badly infested and with leaves discolored. The injury is caused by the nymphs and adults puncturing the undersurface of the leaf and sucking the sap, thus causing at first a mottled effect due to the pale areas around the feeding punctures, while later the leaf turns brown and falls to the ground. Ornamental plantings of Cratægus in parks and gardens may be rendered unsightly and weakened by this injury.

[1] Contribution from the entomological laboratory, Cornell University, Ithaca, N. Y.

Life History

There are two generations of the insects a year at Ithaca. The first brood hatches in July from eggs laid in late May and June, and the nymphs become mature in from 20 to 25 days after hatching. The second brood eggs are laid in late July and August and the adults appear in late August and September.

Hibernation.—The adults of the second brood hibernate among the fallen leaves and in crevices of the bark. Many of them remain on the leaves upon which they were feeding before the leaves fell. They appeared the last of May and during early June at Ithaca in 1918 were feeding on the new Cratægus leaves. As a rule only one pair of adults was found on a leaf and they remained feeding and ovipositing on that same leaf for several days. After emergence from the nymphal skin in September, the adults of the second brood continue feeding on the leaves until the latter fall, in late September or October. The insects were feeding last fall after two heavy frosts.

Egg.—The egg is subelliptical in shape, with the basal end rounded, and the apical end bent slightly to one side and capped with a rather broad cylindrical collar surmounted by a low cone with irregular ridges extending from base to apex. From the apex of this cone there sometimes arises a short blunt prolongation but often this is absent. The egg is without waxy covering over the chorion which is smooth, and unsculptured, and of a shining dark-brown color but somewhat lighter toward the base. The cap or cone is often whitish. The egg exclusive of the apical prolongation of the cap is 0.52 mm. long and 0.21 mm. broad at its greatest width.

The eggs are laid on the under surface of the leaf in the axils formed by the midrib and its lateral branches. Although the female has a well developed, saw-like, four-valved ovipositor, the eggs are not inserted into the leaf tissue. They are placed among the hairs on the veins and are sometimes glued together with an adhesive material. They are generally laid in small groups, some groups containing as many as 18 or 20 eggs and occasionally the eggs are laid singly. In counting the number of eggs on 100 infested leaves I found an average of 49 eggs per leaf. Occasionally a leaf had 75 or 80 eggs on it. The egg-laying period extends over several weeks so that eggs, nymphs and adults may be found at the same time in July and August.

Eggs laid June 2 hatched on July 9 and 10 while the eggs of the second brood, laid July 29 and 30, hatched August 15 and 16. This indicates an incubation period of about 37 days in the cooler temperature of June and 18 days in July and August when the average temperature was higher.

The conical egg cap is pushed up by the nymph as it begins to emerge

from the egg still enclosed in the embryonic membranous sac. When about half way out of the egg shell the nymph splits the membranous sac and slips it off over the head, leaving it with the egg cap on the outer end hanging out from the empty egg shell.

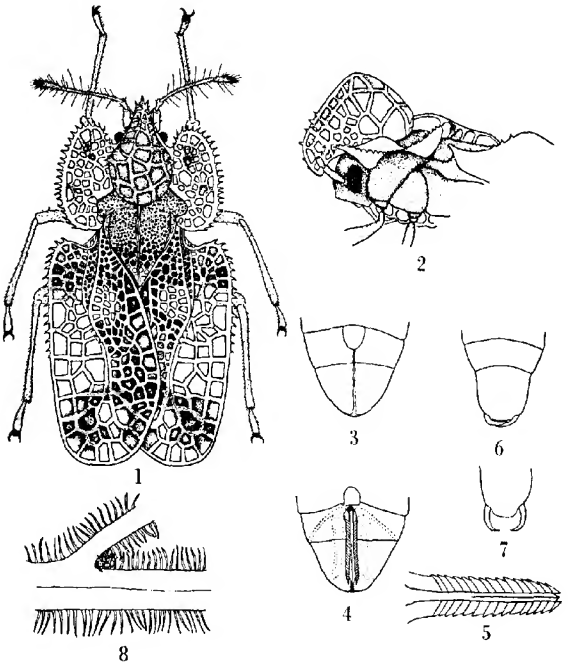

Fig. 24.—1, Adult *Corythucha bellula* Gib.; 2, lateral view of hood and carina; 3, tip of abdomen, ovipositor at rest; 4, same, ovipositor exserted, chitinized tendons within body shown by dotted lines; 5, ovipositor; 6, tip of abdomen of male, claspers at rest; 7, same, claspers exserted; 8, eggs in position among hairs in axil of veins.

Nymphs.—After emerging and drying the nymphs begin feeding at once in colonies near the egg shells. They molt five times, feeding from three to six days between molts, the earlier stages requiring three or four days while the later ones require five or six days. In molting the cuticula breaks along the median dorsal line from the front of the head to about the second abdominal segment. The insect on emerging is limp and almost colorless except the eye facets which are bright red. The body color soon darkens and the eyes a few hours later become

black. During the fifth stage the nymphs wander about more freely over the leaf and sometimes go to adjoining leaves.

Description of Nymphal Stages

First Stage.—Length, 0.5 mm.; greatest width, 0.15 mm. General shape an elongate ellipse somewhat broader cephalad than caudad and more elongate than the later stages. At first almost colorless but soon becoming dark brown. Beak 4-segmented and extending back to the sixth abdominal segment. Antenna 3-segmented, the basal two segments being shorter than the third segment. The basal segment is without spines or hairs, the second segment has a few short hairs, the third segment has numerous long spines and hairs; some with rounded tip and conical base, others with pointed tip. Head with five prominent dorsal tubercles, two slightly separated just above the base of the beak, each bearing a round-tipped spine; one tubercle back of these on the median line bearing two spines; two tubercles near the posterior margin widely separated and each bearing two spines. Pro- and mesothorax have lateral tubercles with a spine on each and the mesothorax has a pair of dorsal tubercles with one spine on each. Metathorax and first abdominal segment are without spines. Legs armed with short pointed hairs and two bent sharp terminal claws. There are nine abdominal segments visible above and each of these excepting the first bears a tubercle surmounted by a round-tipped spine, on both lateral margins of the segment. Two dorsal tubercles are on the second, fifth, sixth, and eighth abdominal segments; those on the second and eighth bearing one round-tipped spine each, and those on the fifth and sixth bearing two spines each. The tenth abdominal segment may be seen from a lateral or ventral view and this segment bears no spines or hairs. Minute awl-shaped spinules occur over the dorsal surface, especially on the large tubercles of the fifth and sixth abdominal segments and on the thorax.

Second Stage.—Length, 0.68 mm.; greatest width, 0.27 mm. The body broader in proportion to its length than in the first stage. Dark brown in color with numerous minute spinules over the dorsal surface covering it much more completely than before. Additional small spines have appeared on both dorsal and lateral tubercles and the round-tipped spines present before have a slightly longer conical base now.

Third Stage.—Length, 0.82 mm.; greatest width, 0.44 mm. The antenna has four segments now. The round-tipped spines arise from a base longer than the spines and a few small spines have appeared on the tubercles. The pro- and mesothorax are beginning to increase in prominence.

Fourth Stage.—Length, 1.2 mm.; greatest width, 0.7 mm. The wing pads of the mesothorax extend back over the metathorax and first abdominal segment at the sides. The prothorax is more prominent than before. Bases of the round-tipped spines are several times as long as the spines. A few new spines are present on the lateral margins of the pro- and mesothorax and of the abdomen. The color is dark-brown except in an irregular band across the abdomen just caudad of the wing pads and on the lateral thirds of the prothorax where the color is yellowish. The minute spinules cover the entire dorsum, being light colored on the yellowish portions and dark on the brown portions. These spinules are also present on the bases of the round-tipped spines.

Fifth Stage.—Length, 1.6 mm.; greatest width, 0.96 mm. The wing pads now extend back to the fourth abdominal segment at the sides and the prothorax is still more prominent. A few more spines have appeared on the tubercles and many of the sharp pointed spines have become round-tipped. Spines on the lateral margins of those segments covered by the wing pads have disappeared. The yellowish parts

of the prothorax have increased in size and the distal part of the wing pads is yellowish, so the body appears to have two light bands across it. The entire dorsal surface is covered with minute spinules as before.

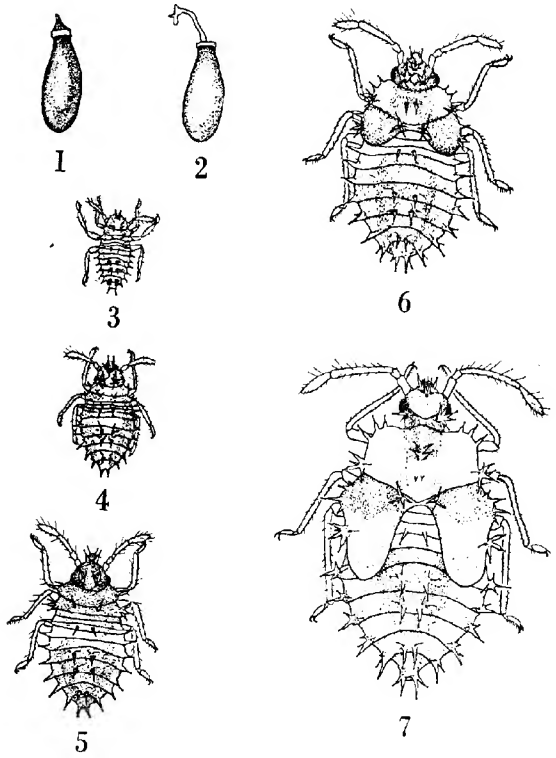

Fig. 25.—1, Egg; 2, egg after hatching; 3, first stage nymph; 4, second stage nymph; 5, third stage nymph; 6, fourth stage nymph; 7, fifth stage nymph.

The larger spines in all the stages of the nymphs correspond exactly in position and appearance with those described by Morrill for the oak tingid, *Corythucha arcuata* (Psyche 10: 128), but in *Corythucha bellula* the minute awl-shaped spinules are more prevalent on the dorsal surface and the nymphs are smaller than *C. arcuata* nymphs. The spines borne on elongated bases have an eversible sac on the tip which gives them a trumpet shape when it is drawn in and a round tip when it is extended.

CONTROL

Many of the last stage nymphs of the second brood were preyed upon by the immature stages of several spiders which spun webs over the leaves. The adults which survive the winter are comparatively few so that the first brood does little injury. In case the second brood nymphs should become too numerous on ornamental plantings they may be controlled by using one of the nicotine sprays commonly used against leaf bugs on apple. The sprays must be directed upward to cover the undersides of the leaves.

THE FUNCTION OF THE ANAL COMB OF CERTAIN LEPIDOPTEROUS LARVÆ

By S. W. FROST, *State College Research Laboratory, Arendtsville, Pa.*

Lepidopterous workers are aware that certain larvæ possess a comb-like structure on the ventral aspect of the last abdominal segment. Heretofore this comb has served simply as a convenient systematic character for separating closely allied larvæ such as *Laspeyresia molesta* Busck and *Laspeyresia prunivora* Walsh from *Laspeyresia pomonella* Clem. The writer has discovered a more interesting and, from the standpoint of the larva, a more useful function of the anal comb. While examining a larva of *Sparganothis indæusalis* Walk., a pellet of frass was tossed with considerable force against the wall of the container in which the larva was kept. Upon further examination the use of the anal comb was revealed. The frass flows out from the posterior end of the alimentary canal in a small pellet. The anal comb is then bent downward until it touches the frass and with a sudden snap backwards it tosses the pellet away from the body.

This interesting performance led to the examination of several other larvæ, both with and without the anal comb, with the idea of determining if any correlation exists between the habits of the larva and the possession of the anal comb. Fourteen larvæ were available for the examination, all feeders of apple and representing various larval habits as: Case bearers, leaf miners, borers, and external feeders.

The case bearers, leaf miners and borers possess no anal comb and an examination of their habits explains the uselessness of such a structure. For example, *Mineola indiginella* Zellar and *Tmetocera ocellana* Schiff., construct trumpet-like cases from which they feed. The frass is removed from the interior of their cases by means of their mandibles and placed on the exterior of their cases. A comb would be of no

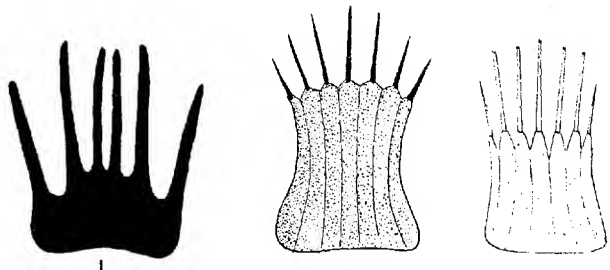

Fig. 26.—1, *Laspeyresia molesta* Busck; 2, *Sparganothis indaeusalis* Walk.; 3, *Archips rosaceana* Harris.

advantage to these larvæ but on the contrary would be a decided disadvantage because it would toss the frass beyond their reach. Again, *Laspeyresia pomonella* Clem., is strictly a boring insect, working within the fruit. As might be supposed an anal comb would be of no use to a larva in a burrow of this sort. The larva pushes its frass from its burrow and has no need of a comb. Finally three other larvæ were examined representing the leaf-mining habit namely, *Tischeria malifoliella* Clem., *Lithocolletes blancardella* Fab., and *Ornix geminatella* Packard. Here again the anal comb would be of no use to the larvæ because they are confined between the epidermal layers of the leaves and the frass could not be tossed away from the body.

On the other hand the larvæ, feeding externally on the leaves or fruit or more or less protected by curled or dried leaves, do not show any definite correlation between the habits of the larvæ and the possession of the anal comb. For example, *Stenoma algidella* Walk., and *Graphiphora alia* (Authors) possess no anal comb while other larvæ as *Sparganothis indæusalis* Walk., *Eulia velutinana* Walk., *Archips rosaceana* Harris, *Ancylis nubeculana* Clem., *Peronea* sp., and *Laspeyresia prunivora* Walsh, have a distinct anal comb.

It is evident that in some cases, at least, a definite correlation exists but the writer does not intend this article to be conclusive as but a very small number of larvæ are considered. Some one with a long series of larvæ available may find the correlation even more interesting.

INSECTS ATTACKING SUGAR CANE IN THE UNITED STATES

By T. E. Holloway and U. C. Loftin, *Bureau of Entomology, U. S. Department of Agriculture*

Following the general plans of Mr. D. L. Van Dine (1) in Porto Rico and Mr. G. E. Bodkin (2) in British Guiana, the writers have compiled the following list of sugar cane insects of the United States. Thanks are due the various specialists for determinations, and acknowledgment is made to Mr. E. R. Barber and Mr. George N. Wolcott for several species collected by them.

1. *Diatræa saccharalis crambidoides* Grote.

Determined by H. G. Dyar.

Common names: The borer, the sugar cane borer, the sugar cane moth borer.

Parasites:

Native: The egg parasite, *Trichogramma minutum* Riley.
Determined by A. A. Girault. Very common.

The egg parasite, *Ufens niger* Ashmead. Determined by A. A. Girault. Reared once from eggs collected near Brownsville, Tex. Apparently rare as a parasite of *Diatræa*.

Introduced: A tachinid fly, *Euzenilliopsis diatrææ* Towns.
Determined by C. H. T. Townsend and described (3) by him as new. Introduced by the writers from Cuba in 1915. Though it attacked the sugar cane moth borer in Louisiana, it has apparently since died out. Further introductions are being made.

Remarks: The sugar cane moth borer is by far the most injurious insect to sugar cane in the United States. Though it attacks corn, it should not be confused with the corn stalk borer, *Diatræa zeacolella* Dyar, which has a different geographical distribution (4, 7), and only rarely attacks sugar cane.

2. *Diatræa lineolata* Walker.

Determined by H. G. Dyar.

Parasite: A braconid reared by Dr. A. W. Morrill at Phoenix, Ariz.

Remarks: This borer, similar to *D. saccharalis*, has the distinctive habit of feeding on the leaves until quite large. It has been observed at and near Phoenix, Ariz., on sugar cane and Johnson grass by the authors.

3. *Pseudococcus calceolariæ* Mask.

Determined by E. E. Green.

Common names: The sugar cane mealybug, *pou-a-pouche*.

Parasites: Several hymenopterous parasites not yet determined.

Predator: The ladybeetle, *Crytolæmus montrouzieri*, has been introduced several times, but has not become established.

Associates: The Argentine ant, *Iridomyrmex humilis* Mayr, and other ants.

Remarks: Common in restricted districts in southern Louisiana. It would be of much importance if widely distributed.

4. *Pseudoccus calceolariæ minor* Mask.

Determined by E. E. Green.

Remarks: Only a few specimens collected on sugar cane near Orlando, Fla., in 1913.

5. *Ligyrus rugiceps* Lec.

Common name: The sugar cane beetle.

Remarks: Occasionally injurious to young corn and sugar cane plants in restricted districts. Later in the season, however, little or no injury which can be attributed to this species can be found in cane fields where there was much injury in the spring, the cane plants sending out "suckers" to replace the dead plants.

6. *Lachnosterna antennata, L. burmeisteri, L. crassissima, L. congrua, Cycocephala villosa* Burm., *Dyscinetus trachypygus* Burm.

Determined by J. J. Davis.

Common names: (larvæ) white grubs. (Adults) May beetles, June bugs.

Remarks: Not noticeably injurious owing to small numbers.

7. *Sphenophorus cariosus* Oliv.

Determined by W. Dwight Pierce.

Remarks: Only one specimen of this large weevil was found in a young sugar cane plant near Houma, La., in 1916. This species would undoubtedly be very injurious if it were common.

8. *Limnobaris sp.*

Determined by W. Dwight Pierce.

Remarks: This is a small weevil, about the size of a corn weevil. The adults are often seen on the leaves of sugar cane during the summer. The larvæ make small borings in old cane stubble. No known injury can be attributed to this species.

9. *Dræculacephala mollipes* Say.

Determined by O. Heidemann.

Common names: The sharp-headed grain leafhopper (6).

Parasites: The eggs are parasitized by *Abdella acuminata* Ashmead and *Gonatocerus koebelei* Perkins. Determinations by A. A. Girault.

Remarks: Owing to the very efficient egg parasites, this leafhopper is of no economic importance.

10. *Dræculacephala mollipes minor* Walk.

Determined by O. Heidemann.

Parasites: Same as above.

Remarks: Same as above.

11. *Tomaspis bicincta* Say.

Determined by O. Heidemann.

Remarks: This froghopper is rare on sugar cane.

12. *Aphis bituberculata* Wilson.

Determined by H. F. Wilson and described (5) by him as new.

Common name: Brown aphis of sugar cane.

Associate: The Argentine ant (*Iridomyrmex humilis* Mayr.)

Remarks: This aphis is not common nor injurious.

13. *Sipha flava* Forbes.

Determined by George N. Wolcott.

Common name: The yellow sugar cane aphis.

Remarks: Found on cane in Louisiana only once—at Angola, La.

14. *Leucotermes flavipes* Koller.

Determined by Thomas E. Snyder.

Remarks: This termite has been found damaging planted seed cane. The injury is not common, however.

15. *Frankliniella gossypii* Morgan.

Determined by A. C. Morgan.

Remarks: This thrips is of no economic importance.

16. *Uropoda sp.*, *Tetranychus modestus* Bnks (apparently), *Bryobia pratensis* Garman, *Galumna robusta* Bnks, *Hypoaspis sp.*[1]

Determined by Nathan Banks.

Remarks: These mites are of no economic importance.

17. *Succinea luteola* Gould.[1]

Determined by Paul Bartsch.

Remarks: A snail sometimes common on leaves and stalks of sugar cane in the Lower Rio Grande Valley of Texas. Of no economic importance.

18. *Laphygma frugiperda* S. & A.

Common names: The fall army worm, the southern grass worm.

Remarks: The larvæ of this common moth occasionally feed on the leaves of sugar cane but rarely do much damage.

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[1] Included in this list for convenience.

INVESTIGATION OF CONTROL MEASURES FOR WHITE GRUBS AFFECTING SUGAR CANE IN QUEENSLAND

By J. F. Illingworth, *Gordonvale, near Cairns, North Queensland*

After two years of this investigation I am more and more impressed with the tremendous importance of the problem. Furthermore, I appreciate that any successful methods of control should have a far-reaching importance; for in many sugar-growing countries, as the newer areas are opened up, these insects appear to be on the increase.

Investigation of control measures for white grubs injurious to field crops is as old as Economic Entomology—more than thirty years ago we find that these pests were a serious menace in Europe. When the cockchafer appeared in Denmark in 1887 the government got behind a movement for collecting the beetles by hand, which was carried out so persistently and economically by the people that the country was apparently quickly rid of the pest. Naturally similar methods have formerly been advocated for Queensland, and, in some localities vast quantities of the beetles were collected, at great expense to the growers: but with little apparent result. The only explanation that suggests itself is that areas collected were comparatively small and the price demanded for collecting would bankrupt a state, if all the beetles were collected. These insects are indigenous on the wild grassland, which is very extensive in North Queensland—much more so than the narrow belts of cleared agricultural lands. It appears to me, something like a proposition of picking up all the insects on a square foot, in the middle of a large field, then expecting that this small area would be freed of the pest for succeeding crops. We get the same result—the beetles swarm over it again from the surrounding infested lands, so that no noticeable benefit appears.

Damage Done by Grubs

An estimation of the vast economic importance of this pest in North Queensland is difficult to formulate. First of all, we should consider the immense areas which have gone out of cultivation, solely because of the grubs. On the friable red-volcanic soils, which are of high fertility, this is particularly true. Even much of the land that is now planted to cane will soon go out, unless some relief is furnished. The most distressing part of the situation is that the grubs wait until all the work of planting, chipping and cultivation is finished, and the cane is laid by—all the expense has been put into it—when the grubs begin their devastation. It is heartrending to view the ruin on an estate like Greenhills in the Cairns district, where hundreds of acres of beautiful,

perfect cane goes down to destruction within a few weeks, during March. Once the roots are eaten off, the slightest wind pushes the stools over in that loose soil; then deterioration quickly sets in.

In 1911, a conservative estimate[1] of the annual loss in the Cairns district, through grubs, was 25 to 30 thousand tons; and this loss continued year after year in spite of all efforts to combat the pest. In one year the Cairns growers collected 22 tons of beetles and 9 tons of grubs, at an expense of over £3000; with no apparent diminution in the pest. On this point the following interesting figures[2] will help one to understand what a ton of beetles represent: One pound of beetles equals 250; in one ton there are 560,000 beetles, 60 per cent females equals 336,000 each laying eggs which produce 25 fully grown grubs equals 8,400,000. Since it is estimated that 16,000 grubs are sufficient to destroy one acre of cane; one ton of beetles, therefore, could destroy about 500 acres of cane.

From data at hand, it is easy to see that in all the cane-growing districts of Queensland, the losses from the grub pest alone undoubtedly run into hundreds of thousands of pounds.

Combating the Pest

I must admit that the problem seemed hopeless at first; but I am beginning to see light. In fact, I am more and more encouraged as the investigation proceeds.

Control measures have been developed along several lines, the most important of which are: (1) stimulating vigour in the plant, (2) egg-destruction by cultivation, (3) application of poison, and, (4) removal of feeding-trees.

There are numerous factors which bring about increased vigour, and all of them should be considered as valuable aids in combating the pest, for if the cane is in a thrifty growing condition it will resist the grubs to a considerable degree. Among these factors, I would suggest, the application of lime and fertilizers, supplying humus, and thorough cultivation.

Lime, as every grower knows, improves the physical condition of clay soils, and assists in the rapid change of plant-refuse into humus. It improves the health of soil bacteria and fungi, in other words, which are all-important in the growing of crops. It is well recognized, too, that a leguminous green-crop does very poorly on land without lime, which is essential to the bacteria forming the nitrifying nodules on the roots.

The use of fertilizers is important to the growing of any crop, but

[1] Aust. Sugar Journal, Vol. 3, p. 199.

[2] Aust. Sugar Journal, Vol. 2, p. 443.

this is particularly true with sugar cane, for experiments have demonstrated that a 30-ton crop removes from the soil 102 pounds of nitrogen, 65 pounds of potash and 45 pounds of phosphate. Land poor in these elements naturally produces cane of inferior quality, which easily succumbs to grub injury. Experience has shown, that for best results, small experimental plots should be developed in each locality, or class of soil. In Hawaii this diversified testing is done by the Planters' Experiment Station, with such efficiency that they have found that under certain conditions it pays to apply 1,200 pounds of mixed fertilizers, containing 11 per cent of nitrogen, and on top of this, to add as much as 500 pounds of sulphate of ammonia or nitrate of soda. That is to say, the idea is to apply as much fertilizer as will produce a profit. They also use lime freely. It is by such methods that the output of these small islands has been increased from 75,000 to over 600,000 tons of sugar, in the history of the Station.

Comparatively speaking, little fertilizer is used in Queensland; many of the newer farms get none at all. Consequently, I wish to emphasize not only the value of manures as a factor in grub-control, but further to say that under scientific application they will pay a handsome profit on most soils.

Speaking generally, grubby-soils are lacking in humus. This is true of all of those that I have tested. Experiments have demonstrated that the grubs prefer partly decayed organic matter to living roots. As a matter of fact, they live happily, and develop well in rich soil alone, even when all roots, trash, etc., are removed. Moreover, it is a well-known fact that their bodies are always full of earth during the feeding period; and from this they derive their principal supply of nutriment, by extracting the humus, if present.

Where soils are poor in humus, and all organic matter is removed by the destructive methods of farming now in vogue in Queensland, the grubs are compelled to feed upon the living roots or starve. Furthermore, we know that humus has a remarkable affinity for arsenic, which may be made use of, as I shall point out, later.

What is needed is a method of conserving all trash, and waste from the crop, together with a regular rotation of green-crops. Sooner or later all farms must come under this practice, if the productivity of the land is to be maintained. In line with this advice, I wish to call attention to the large areas at Goondi—the Mundoo section, which produced splendid crops of cane for a few years, but now, is said to be so worn out that it will not pay to work. Apparently many other cane areas are fast approaching this condition, even though only a very few crops have been taken off.

I have emphasized surface cultivation mainly because of its value for

increasing the vigour of the crop, and in this way making the plants more resistant to attack. However, as I shall indicate later, I have found that it often has a more direct action in the destruction of the pest.

Undoubtedly the value of cultivation is recognized; but on many farms it is not carried out. Climatic conditions bring about great difficulties, in this regard, particularly with the late-planted crop. Many soils can not be worked properly when either too wet or too dry, and as a consequence the cane is left to suffer. However, it is common experience that the man who cultivates well is the man who reaps the reward.

I have found by extensive experiments at Greenhills, during the past season, that both the eggs and the young grubs are considerably injured by even shallow cultivation, for they are located near the surface in December. The common cultivators, reaching to a depth of about six inches, are satisfactory for this work; though I got somewhat better results by using a pony-plow, which got in closer to the roots.

In order to be effective this work must start at the time the beetles begin to emerge, and be continued, going over the ground every fortnight while they are on the wing. Normally, this would mean about four cultivations, which would mean no extra work in the case of late cane. I have advocated September-October planting on grubby-soils, where they are well drained, so as to facilitate this cultivation during the flight of the beetles; the plants are then small enough so that the implements can get well under them.

We have had encouraging results in the use of arsenic for the destruction of the grubs. I found that by using arsenious acid (white arsenic) with Greenhill's soil in pots, that full grown grubs were quickly destroyed by ingesting it,—all of them dying in one to four days. The quantity used was approximately what would amount to about 20 pounds per acre. I should state that only sifted soil and arsenic were placed in the pots, so that it was demonstrated that the grubs were destroyed by feeding on the poisoned humus of the soil.

Arsenic was used on our experimental plots at Meringa, in varying proportions and combinations; the best results apparently being from the use of the poison placed in the drill with the plants. In this case 20 pounds was mixed with 5 cwt. of meatworks manure per acre. The cane came along splendidly, with no sign of grub-injury, while several of the other plots showed more or less infestation.

Apparently the most satisfactory and far-reaching remedy, however, is the removal of all feeding trees, within a radius of about half a mile of infested cane areas. Investigation has demonstrated that once

this is done the land becomes immune. This fact is particularly noticeable in the older districts, like the Herbert River and Goondi, where all the land was once more or less infested. Now that the clearing has been far extended, all of the older fields are immune; the only infestation being on the lands laying near the feeding trees. Hence we might justly conclude, that by concerted effort, many of the infested lands could be freed of this pest forever.

Conclusion

As would appear from the above, the outlook is rather encouraging, in spite of the fact that the investigation has been carried on under many difficulties. It has been real pioneering. The spirit of unrest makes it hard to get the backing that a problem of such magnitude requires.

Practical results can only come from extensive application in the field. Already this is started in a small way, but it will take several years of conscientious investigation to bring about conclusive results.

A SUCCESSFUL METHOD OF BREEDING PARASITES OF WHITE GRUBS

By J. F. Illingworth, *Gordonvale, near Cairns, North Queensland*

Since Scarabæid beetles are found probably more abundantly in Australia than in any other part of the world, we naturally find their parasites well developed. Among these parasites numerous wasps have been recorded—about 50 species, according to Froggatt[1] have been described from Australia. I have come in contact with only three of the principal ones, in my investigation of the several species of white grubs that attack sugar cane in North Queensland.

In order to know more definitely the habits of these friendly insects and to try to learn something of the relation of their hyperparasites, I instigated breeding work in the laboratory in 1917, using our two most abundant species (*Campsomeris tasmaniensis* and *C. formosus*).

My assistant, Mr. E. Jarvis, carried out most of the work, since my time was largely occupied in the field. At the time that the breeding was started, in December, the wasps were very numerous, flying over grub-infested lands near our Station. From these I collected several females, and found them very amenable to handling in small cages. When placed in covered tins, holding about half-a-pint of soil, they "dug themselves in" at once. Our usual practice was to place a grub in each of these tins, removing it whenever an egg was found attached

[1] Australian Insects.

to its venter. The wasps were supplied with food by placing small drops of diluted honey on a bit of leaf on the surface of the soil, before covering the tins. When hungry the wasp came up, and though it was dark in the tin, she licked up the nectar and straight way went back to work.

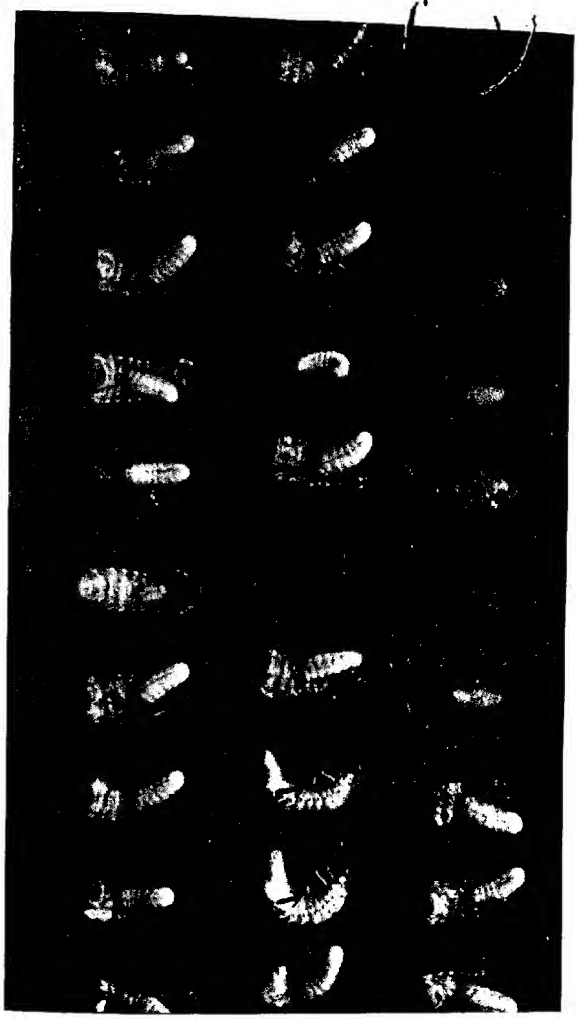
At first we only got an average of about one egg in two days from each wasp; but after observing the activities of a specimen which I had placed in a glass jar containing soil, I saw one of the difficulties. The wasp spent hours mining, round and round the jar, dragging the paralyzed grub after her, evidently in an endeavor to get it deep enough where the soil would remain moist, before forming a chamber and laying her egg. By supplying more moisture and examining the tins several times a day, I found that it was an easy matter to get a wasp to lay twice daily, and, in some cases as many as three eggs were produced in 24 hours.

It is interesting to note that when I put several grubs in the tin, the wasp straightway paralyzed them all, though she never laid on more than one. This led me to the conclusion that two eggs per day was perhaps her maximum average.

Mr. Jarvis experimented with various methods of caring for the grubs after they were parasitized, but none proved satisfactory for breeding on a large scale. They all required too much handling.

I, therefore, set to work to devise a plan, and began using boxes similar to the ordinary greenhouse "flat," a number of which I made up. These wooden trays are about 12 by 14 inches, inside measurement, and three inches deep. Soil two inches deep was firmly pressed into each of them and this was then indented with many oval cavities, just the shape of the bottom of the normal cell which the wasp makes in the soil, for the grub. I finally made a mold to form these depressions in the soil very rapidly; and I was able to get exactly 60 of them for each tray. See plate 19.

As fast as the grubs were parasitized, they were placed in these depressions on their backs and it was not necessary to handle them again. By this method they were as well separated as if in their original cells in the soil and they could not disturb one another; hence, the larvæ of the parasites developed very satisfactorily. However, when they finished feeding, and tried to spin up their cocoons, I found the same trouble that Mr. Jarvis had experienced when he kept the parasitized grubs in the bottom of small jars—the larval wasps were often unable to form the upper side of the cocoon, since the earthern cells had no roofs to act as points of attachment. In the case of the jars, I found that the cocoons were readily completed whenever I



Showing various stages in the development of wasps, as they appeared in the trays. Arrows indicate eggs in position. Cocoons of the wasps are to be seen in the cells on the right (Reduced, see scale).

dropped a bit of paper over them. I tried this in the trays when the larvæ were feeding, and found that it worked equally well.

The cocoons were then left in the cells to emerge; attention being given to keep the soil from drying out. There was not much difficulty experienced in this matter, since I kept the trays stacked, one upon another.

A small glass tube was inserted into the end of each tray, and this being the only entrance of light, the wasps naturally came into the tubes as fast as they emerged, and were easily removed.

It will be interesting to record here a further instance of parthenogenesis among parasitic hymenoptera. We found that wasps reared in the laboratory, with no opportunity for mating, began egg-laying at once when grubs were provided, and these eggs hatched producing larvæ of both sexes, though there was a preponderance of males, as one would naturally expect. However, these unmated females produced fewer eggs than normal, and the offspring emerged poorly.

THE SUGAR CANE BEETLE BORER PARASITE (CEROMASIA SPHENOPHORI) IN QUEENSLAND

By J. F. ILLINGWORTH, *Gordonvale, near Cairns, North Queensland*

This valuable Tachinid fly, introduced from New Guinea, in 1910, by Frederick Muir of the Hawaiian Planters' Association, has become thoroughly established in the Mossman district, and has done inestimable good.

It may be recalled that the beetle borer (*Rhabdocnemis obscura*) came into North Queensland, accidentally, about 1893, with importations of seedcane from New Guinea. This serious cane pest, which is second only in importance to the white grubs, has become well established in most of the northern districts, and already extends as far south as Mackay. Furthermore it is rapidly spreading to new territory through the indiscriminate exchange of seed between the different sugar centers.

The importance of this pest has long been recognized, especially by the Colonial Sugar Refining Company, who own a number of mills in the infested districts; and they made a serious, though unsuccessful attempt, in 1914, to introduce these Tachinid parasites from Fiji, where I had bred them and established colonies during 1913. They bred the flies in large field-cages at Goondi, on the Johnstone River; and though good-sized colonies were liberated, the parasites failed to become established. The season of 1914 was exceptionally wet; and as

that district normally has a heavy rainfall, it may have hindered the reproduction of the parasites, just at the time that they were getting started. This failure, however, led to the conclusion that, for some unaccountable reason, the Tachinids could not be established in North Queensland. Taking the above into consideration, I was particularly gratified to find that the flies had not only maintained their existence at Mossman, but had actually spread to even the most-distant portions of the district.

Previous to 1910 the beetle borer had become a serious pest at Mossman,—a fact which probably led Muir to select this locality as a station in his transfer of the parasites from New Guinea to Hawaii. In his bulletin[1] he states that before leaving Mossman it was found that a few of the escaped flies had established themselves in cane near the cages and were breeding quite freely. His work was carried on in the Mill Nursery; and fortunately for the parasites, this cane was not fired annually as is the custom with the ordinary field crops; hence there was an abundance of borer grubs, and the flies had every opportunity to multiply. Furthermore, seedcane was taken from this nursery to various parts of the district, and this undoubtedly was an important factor in the rapid distribution of the parasites. At any rate, in one case I found them fully 15 miles distant from this center, with long stretches of forest intervening.

The borer beetle is no longer a serious pest in the Mossman district —in fact it is thoroughly under control. In standing cane, it is now a difficult matter to locate a borer-grub that has escaped the vigilant search of these friendly insects. During the collection of the parasites for transfer to other infested districts, I estimated that fully 90 per cent of the grubs were destroyed by the flies. It was only where the stalks had fallen and were buried up by trash, that the grubs escaped.

The fact that these parasites have done so well at Mossman, is certainly very encouraging for their introduction into other nearby infested districts. This work I have undertaken as opportunity arose.

At first I tried transporting the parasitized grubs in the canes to the fields where I wished to establish the flies; but finding this a bulky procedure, I later collected only the grubs and puparia of the flies, which I carried in jars. By this method the grubs do not injure one another if a good quantity of frass is placed in the jars with them. I found it better, however, to separate the puparia into another jar, as fast as they emerged, to prevent the grubs destroying any that happened in their way.

By keeping the puparia covered with a plentiful supply of the frass

[1] H. S. P. A. Bul. 13, Ent. Ser.

it was easy to maintain correct moisture and air conditions, until the flies emerged, when they were placed directly in fields of borer-infested cane.

I have advised leaving the trash on the fields where I liberated the parasites, for at least one season, since the usual practice of burning when the crop is cut, though beneficial in destroying borers, is probably a rather serious set-back to the flies, until they are well established. Once they get a foothold, however, burning does not do them serious injury, and it is the best means we know of checking the borers. As a matter in point, all of the cane land in the Mossman district is burned over at the time that the crop is harvested, and still the flies maintain themselves well.

Natural Enemies of the Parasites

As I found in Fiji, the ants (*Pheidole meyacephala*) are omnipresent in the cane fields of North Queensland. They often make their homes in the borer-runs, after clearing out the accumulated frass. Naturally predaceous, they are always ready for the flies as they emerge; and if they get them before their wings are expanded, the flies fall an easy prey. I have even observed the attack of the ants upon the mature insect, which is quickly overcome if they succeed in attaching themselves to the legs; the fly is then dismembered and carried away. It is only the perfectly healthy parasites that are able to escape, by eternal vigilance.

Fortunately, jumping spiders are not abundant in cane here, for they are a mortal enemy of the flies during the whole of their adult existence.

Swallows, and other insectivorous birds, are rather numerous in the fields, but I am not of the opinion that they act as a serious check upon parasites of this character, since the flies tend to spend their time down among the stalks of the cane plants, in their search for the borer grubs.

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A PRELIMINARY NOTE CONCERNING A SERIOUS NEMATODE DISEASE OF RED CLOVER IN THE NORTHWESTERN STATES

By RALPH H. SMITH, *Associate Entomologist, University of Idaho, Moscow, Idaho*

Soon after taking up work in Idaho in May, 1918, the writer was asked to examine several fields of red clover in which the greater percentage of plants had either died or showed evidence of being badly diseased. The symptoms of the disease at this time were something like those of the stem rot of red clover that is caused by the fungus, *Sclerotinia trifoliorum* Erks. The widespread destructiveness of the malady during the autumn and early winter led to a careful investigation of the cause, with the result that the well known stem and bulb nematode of Europe, *Tylenchus dipsaci* Kühn, was found to be the primary pathogenic organism. No trace of any fungous parasite was found. Determination of the species was made by Dr. N. A. Cobb of the Bureau of Plant Industry.

Information that has been obtained from farmers indicates that this disease of red clover has been present in southern Idaho for several years and that it is rapidly increasing in its destructiveness. During the spring of 1919 several hundred acres of red clover had to be plowed up while a large percentage of the fields left were quite badly affected. The known distribution of the disease is limited chiefly to the irrigated sections of eastern Washington and Oregon, southern Idaho, and northern Utah.

The causal organism, *Tylenchus dipsaci* Kühn (syn. *devastatrix* Kühn) has been a well known destructive nematode of Europe since 1851 when, according to L. Reh,[1] it was described by Julius Kühn. It is remarkably polyphagous, having upwards of one hundred known species of host plants. In Europe it is a pest of clover, alfalfa, oats, rye, wheat, buckwheat, hops, beans, potatoes, onions, certain grasses, various ornamental plants, and numerous weeds. In England it is a leading cause of the malady long known as "clover sickness." During the past ten years it has become an important pest of different crops in New Zealand, Australia, and Cape Good Hope.

The occurrence of *T. dipsaci* in North America was first reported by Dr. E. A. Bessy who found it damaging a field of rye at Edgerton, Kansas, in the summer of 1907.[2] It was next discovered in the summer of 1913 at Bellingham, Washington, where it was the cause of a disease of hyacinths.[3] In 1915 Professor A. L. Lovett found it injuring red clover at Redmond, Oregon.[4] During the summer of 1916 Doctors N. A. Cobb and L. P. Byars of the Bureau of Plant Industry prepared

an article concerning the discovery of this pest in the Northwest and the article was distributed through the Office of Information of the United States Department of Agriculture. A reference to the disease of red clover was made in 1918 by Mr. A. C. Burrill who suggested that the trouble might be due to the attack of certain mites and the larvæ of the fungus gnat, *Sciara trifolii* Pett.[5]

Red clover seems to be the only plant that is seriously affected in the Northwest although occasional instances have been observed where alsike and white clovers were injured. This limited range of host plants may possibly be explained by the statement of certain European writers that there are different "biological strains" of *T. dipsaci*, each strain being specialized in its feeding habits to one host plant or to a few closely related host plants, so that it is unable to readily attack other species of the large number of plants that are listed as hosts of this nematode. It remains to be seen if the *T. dipsaci* that is causing such severe damage to clover in the Northwest will eventually become a pest of the numerous crops which the species is said to attack in Europe and other foreign countries.

The nematodes appear to enter the clover plants at the surface of the ground, first working into the stipules of the leaves which surround the developing stems and later entering the stems. The infested parts near the ground become enlarged, spongy, and finally turn brown and rot off. The worms also occur higher up in the stems, and in the leaves and branches where they cause distortions and enlargements. The malforming of plants is most pronounced in autumn and early winter. During the summer the foliage of affected plants usually has an unhealthy, striped-yellow appearance and the plants as a whole are more or less stunted.

The death of diseased plants is hastened in the greater number of cases by the work of secondary agents, the most important of which seem to be the root mite, *Rhizoglyphus rhizophagus* Banks, the larvæ of the mycetophilid, *Sciara trifolii* Pett., and the larvæ of *Sitones hispidulus* Germ., a snout beetle that is common in clover fields in the Northwest. The greater injury results to clover fields the second year or longer after seeding when both the nematodes and the insects are found to be more abundant. Several fields have been observed, however, which had to be plowed up the first year after seeding.

Considerable work on the control of this nematode has been carried on in Europe and such measures as trap plants, rotations with immune crops, deep plowing, fallowing, application of various chemicals to the soil, and intensified cultivation have been recommended. It has been found that the larvæ of the worms can remain dried up for a period of two and one-half years without loosing their viability. This, along

with the possibility that the worms may come to thrive on many of the common weeds and field crops of the arid sections of the northwestern states, as it does in Europe, presents a more serious problem of control than has been dealt with by European investigators. The writer has made studies which show that the nematodes may be spread through the hay, straw, and, to some extent at least, through the seed from infested clover fields. They are also doubtless carried on the feet of animals, the wheels and other parts of farming implements, and to some extent in the water of irrigation ditches. It is probable that irrigation water plays an important part in spreading the worms from infested plants to other plants in the same field.

It is anticipated that the futher investigation of the problem will be conducted as a coöperative project between the Idaho Experiment Station and the Bureau of Plant Industry.

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A MIGRATING ARMY OF MILLEPEDS

By Fred E. Brooks, *Bureau of Entomology, Entomologist, Deciduous Fruit Insect Investigations*

During the past fifteen years the writer has on several occasions observed in the central part of West Virginia armies of millepeds, *Fontaria brunnea*, migrating over the ground in woods and fields. These armies have moved either in scattered or densely formed companies, sometimes only two or three to the square foot and at other times averaging a hundred or more to the square foot. In one or more instances the millepeds have been known to invade strawberry plantations at the time the fruit was ripening where they would coil about and feed upon the over-ripe fruit and so cover the ground about the plants that picking of the fruit had to be abandoned. One man informed the writer that while gathering wild blackberries he chanced to look down and saw his shoes and all the ground about them covered with a mass of crawling thousand-legged worms, whereupon he beat a hasty retreat. Such armies have been seen by the writer at Hampton and near Buckhannon, in Upshur County; near Weston, in Lewis County; and, more recently, near Littleton, in Wetzel County.

Early in July, 1918, the local newspapers published accounts of "a great army of worms" which was causing much discomfort and excitement in the vicinity of the village of Littleton, which is situated on the Grafton-Wheeling division of the Baltimore & Ohio Railroad. The writer, being in the locality, took the trouble to investigate, and, on July 13, found a remarkable occurrence of millepeds, specimens of which have been determined by Popenoe as *Fontaria virginiensis* Drury. The army had first been observed about four weeks previously moving in a southerly direction over the farm of two brothers, L. L. and James Fox, about one mile from Littleton. At least seventy-five acres of field and woodland had been covered with the millepeds, which, in the opinion of the Fox brothers, came from a tract of woodland nearby, known as the Welsh Woods. Both the brothers stated that a small barn on the farm was at one time covered with a solid mass of the creatures from the ground to the tip of the roof and that they formed in heaps about every decaying stump and piece of mouldering wood. The spring from which the families obtained water was filled to a depth of six or eight inches with drowned millepeds and water for all uses had to be carried from without the infested area. Cattle refused to graze on pastures invaded by the army, and, in cultivating corn, the workmen declared they were nauseated and made dizzy by the constant odor arising from the millepeds crushed by the hoes. This odor, they describe as being like that of cherry bark, but much more offensive. It was stated that during the warmer part of clear days masses half as large as a barrel would collect in damp and shady places, but that in cloudy weather and at night the army was moving constantly.

At the time the writer visited the Fox farm the army had passed on and only a few living millepeds could be found. Old stumps, posts, rails and decaying boards, however, bore evidence of the invasion for they were in many places gnawed white and were covered with small dots of earth-like excrement. From information given by the Fox brothers and many other persons, together with what the writer himself saw of the army, it was estimated that the army was composed of not fewer than 65,340,000 millepeds.

When seen by the writer the army had migrated about a mile from the Fox farm and the main part of it was centered about the home of M. G. McDougle, which is at the foot of a high cliff of rocks beside the railroad track. In its movement the army had come to the top of the cliff and the millepeds had descended by crawling or rolling to the bottom. Mr. McDougle stated that on the morning following the coming of the army to his home he opened a screen door between his kitchen and back porch and that the door in swinging back swept

up a heap of the millepeds a foot in height. He immediately got a shovel and cleaned up two washtubsful from the porch and from a small ditch that extended along the side. Every morning thereafter for two weeks he collected a half-bushel or more about his house and carried them away. The barnlot where the family cow grazed was so covered with the millepeds that Mrs. McDougle left her cow unmilked for three consecutive milking times and the small stone cellar in which the milk was kept was so overrun that it had to be abandoned. G. W. Mackey, a Baltimore & Ohio section foreman, said that he saw a pile of the millepeds at the foot of the cliff two feet in height which he estimated to contain five bushels.

At the time of the writer's visit there were thousands of the millepeds crawling over the face of the rocks and on the ground above and below and showers of them were dropping at intervals over the declivity. They had been present about the McDougle home for more than two weeks and all observers agreed that the number was now greatly reduced. The hot sunshine on the bare cliff, and on the railroad ballast at the bottom, was killing them rapidly, as was indicated by the number of dead. In many places at the foot of the cliff the ground was completely hidden by the dead bodies and the stench was offensive. The McDougles had poured lime and concentrated lye on the ground, forming a heavy line around the yard to keep the millepeds from crossing, but with little avail. They stated that neither chickens nor anything else was observed to feed on them. The good woman of the house was almost in despair, for, in her own words, "she had fit those worms with consecrated lye and every thing else she could think of and hadn't been able to do a lick at anything else for nearly three weeks."

Neither mating nor oviposition were observed, although looked for rather carefully. Mrs. McDougle had noticed that some of the millepeds were full of eggs and the writer dissected one rather small female which contained 690 eggs. All the abdominal cavity except the space occupied by the slender alimentary canal was packed full of eggs. Most of the millepeds seemed to be full grown although some were noticed whose immaturity was indicated by the smaller size and paler color.

Reports were current of similar armies at Woodruff, Garrison and Sand Hill Church, all near Littleton, but the writer did not investigate these reports. It is interesting to note that small companies of the millepeds are said to have been seen in woods near Littleton in 1916 and 1917. These may have been the progenitors of the great army that appeared during the present year

Scientific Notes

Occurrence of the Argentine Ant at Raleigh, North Carolina. On September 20 the writer, much to his surprise, found a heavy infestation of this troublesome ant in a floral establishment here. The florist, Mr. O'Quinn, stated that this ant has given him much trouble for about fifteen years, especially in the winter when the workers flock to the green houses for warmth and occur over everything. Mr. O'Quinn also stated that they cause considerable damage to his carnations by cutting off the petals at their bases.

The ants also occur on several blocks adjacent to the florist's establishment, where they are giving the people much trouble by infesting houses.

The only other locality in this state, in which the Argentine ant is known to occur, is Wilmington, where it was found several years ago by Mr. E. R. Barber, of the Bureau of Entomology.

M. R. SMITH,
Extension Entomologist, North Carolina State Department of Agriculture

The Cocoanut Butterfly, Brassolis isthmia, on Banana. My attention was first called to the occurrence of larvæ of *Brassolis isthmia* Bates on banana by Mr. Ignacio Molino of the Bureau of Entomology, U. S. D. A., Temporary Field Station at Ancon, C. Z. He found them on banana trees in his gardens in Panama city. An inspection made September 5 revealed four palms completely stripped, two palms partly stripped, one banana tree with one leaf completely chewed off excepting the stout mid rib, and two banana trees with large holes eaten through several leaves. Larvæ of *Brassolis* were congregated in bunches both on the palms and banana plants. To make sure that the injury noted was done by the cocoanut butterfly, an inspection was made at night the same day. When about ten feet away from the banana trees a very characteristic noise was heard,—that of the mandibles of dozens of large larvæ making rapid progress through the thick, fibrous tissues of the banana leaves. It was a loud noise, not easily forgotten. This inspection confirmed the identification of the species.

The following day, 6th, one entire leaf, measuring 4½ feet by 1½ feet was found to be completely stripped to the mid rib; a few more leaves had large holes eaten through them. The larvæ feed from the dorsal surface, and start from the edge of the mid-rib, working outward. Observations made on subsequent days showed that a large leaf was stripped daily. The inhabitants of the house told me that at first the noise produced by these larvæ was so unique and loud that it interfered with sleep; these people live only about fifteen feet from the trees.

B. isthmia is a very serious pest of palms, principally of our cocoanut palms (see H. F. Shultz, '08, Proc. Ent. Soc. Wash., and L. H. Dunn, '17, Journ. Econ. Ent.). This is the first record of its occurrence on banana, and while it may never become a serious pest of bananas, the fact that it takes readily to banana leaves and eats them with vigor, is enough to emphasize the need of control work. The method that has been recommended is the cutting out and burning of the nests in the palms, however, this method is not thorough enough; it is believed spraying with an arsenical will prove more effective. Attention is called to the fact that in banana plantations there are innumerable cut stalks and other forms of débris scattered about, and that these afford admirable shelter for the mature larvæ when ready to pupate. It would appear, therefore, that if once established on banana, it will become a serious pest. This species should be included in Doctor Pierce's "A Manual of Dangerous Insects Likely to be Introduced in the United States Through Importations."

JAMES ZETEK, *Ancon, Canal Zone*

Stable Flies and Chiggers. While making studies on the chigger mites during the past summer in the vicinity of Washington, D. C., large numbers of stable flies (*Stomoxys calcitrans*) were found to be parasitized by a small red chigger. A determination of the species concerned shows it to be *Trombidium striaticeps* Oudemans, the striated chigger of Europe, which is said to be one of the three species concerned in the attacks on man and domesticated animals in that continent. In view of the fact that the specific identity for all species attacking man and domesticated animals in this country is in doubt, it is believed that the record of the occurrence of this European species in our country is of much significance. That it should be found so abundantly on stable flies in Washington is surprising, yet Dr. L. O. Howard informs me that in the past he has observed stable flies in the vicinity of Washington with chiggers attached.

H. E. EWING

On the Bite of Arilus cristatus. On September 22, 1919, the writer was collecting along the banks of the Potomac River at Williamsport, Md. Adults of *Arilus cristatus*, the wheel bug, were very numerous, engaged in feeding on a large variety of insects and in mating.

A considerable number of these adults were picked up for life-history studies, a male of which sunk its proboscis into the forefinger of the writer's right hand. The wound was at once very painful and remained so for ten days, at first appearing red, and the portion adjoining the wound more nearly, becoming hardened and quite white. On the 26th it was necessary to lance the wound to let out considerable bad blood and puss, and the finger was not normal until about the third of October.

GEORGE W. BARBER,
Scientific Assistant, Bureau of Entomology, U. S. Department of Agriculture

A Note on Migration of Larvæ of the House Fly. Along a stretch of some 150 feet of road in Wellington, Kans., there is found a strip of grass about two feet wide along one side of which a cement sidewalk runs and along the other a cement curb raised perhaps eight inches above the macadamized road with which it is connected. The whole is gently sloping to the West.

About the 15th of May, 1917, this grass area, as well as a plot of some two acres adjoining the sidewalk, was covered with a thick layer of barnyard manure which had probably been stacked for some time.

A few days later, about six o'clock in the morning, in passing by this stretch of road, large numbers of the larvæ of the house-fly, *Musca domestica*, were observed on the sidewalk and in the gutter adjoining the manured strip. They were only fairly numerous on the sidewalk, but in the gutter they lay in a white band extending the whole length of the manured space, perhaps eight inches wide and towards the curb several larvæ deep.

This whole seething mass was working down the street towards the West and were found to be entering a sewage manhole which adjoined the West end of the manured area.

By noon, this date, practically all the larvæ had disappeared.

Considering that the majority of the larvæ had entered the manhole, they had migrated from one to one hundred and fifty feet depending on which end of the manured area they left the manure. And they had preferred migrating this distance in search of soil in which to pupate rather than enter the soil beneath the manure.

GEORGE W. BARBER,
Scientific Assistant, Bureau o Entomology, U. S. Department of Agriculture

Brood X of the Periodical Cicada in Missouri. In Missouri Agricultural Experiment Station Bulletin No. 137, "The Periodical Cicada in Missouri," the writer published the records of distribution of Brood X Septendecim collected by Professor Stedman in the summer of 1902. At the time of preparing the data for publication the writer carefully went over the original records and included only those which seemed without doubt to be accurate.

This brood appeared again this year and a new set of records have been collected and tabulated. The records for 1902 showed the pest to be quite generally distributed over much of the eastern half of the state and in some localities in considerable abundance. It will be of interest to know that if the records for 1902 were correct this brood of the Cicada is rapidly disappearing in Missouri. The 1902 records showed it to be present in thirty-two counties while in 1919 records received just after the time of disappearance showed that Cicadas appeared in only four counties. Cape Girardeau, Hickory, Perry, Puloski and possibly Carter. The localities are widely separated and in no case were the Cicadas abundant. Since early arrivals are known to appear one year in advance of regular broods, it is quite possible that some of the Cicadas observed this year may have been early arrivals of Brood XIX of the thirteen-year form, which appears over most of Missouri next year. Be this as it may it is clearly evident that Brood X is of little consequence in Missouri.

L. HASEMAN.

Swarms of Cotton Worm Moths visit Missouri. Since 1911 the fall migration of the cotton worm moth (*Alabama argillacea* Hbn.) has not attracted any special attention in Missouri, but during the last of September and the first two weeks of October the moths appeared in great numbers in the state, doing some damage to ripe fruit. During this visitation the moths were not nearly so abundant as in 1911 but around piles of decaying fruit, tomatoes, persimmons and other attractive bait they have been observed to collect in swarms. In a moth trap set at Columbia on the night of October 14, facing an orchard and vegetable plats, and at a distance of one hundred yards from them only a few moths were caught. Careful examination on the following day showed that but few moths remained.

It will be of interest to learn if this is another year of extensive northward migration of this queer moth, similar to the fall of 1911.

L. HASEMAN.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Judging from the trend of affairs, it may be necessary to limit more closely than heretofore the acceptance of matter for the JOURNAL. The Proceedings of the Annual Meeting and those of Branch Meetings have by common consent been given precedence in the past. It is presumable that this policy meets with general approval and will be continued. The editor has in the past suggested some condensation or even the withdrawal of papers read at the meeting, this action being based on various considerations. It is not quite fair to submit a forty-minute manuscript for a fifteen-minute paper, though circumstances may very occasionally justify it. The limited resources available make it impossible for the JOURNAL to publish many twenty-page contributions and afford a fair opportunity to the many lines of activity seeking an outlet through its pages. In the same way, the relatively costly tabular matter and illustrations, both desirable in themselves, are self-limiting with our restricted resources. It has been the editor's aim to give preference to new matter, preferably concisely stated, because it is only by observing some such rule that the JOURNAL can under present conditions fill the place it should occupy in economic entomology. There is so much new matter available, that summaries or digests of previously known facts, published illustrations, exhaustive tabulations and detailed accounts of investigations all come in a class which conditions make it difficult to publish unless justified by special considerations.

CURRENT NOTES.

The fall field meeting of the New Jersey Beekeepers Association was held at New Lisbon, September 10.

The fifty-sixth annual meeting of the Ontario Entomological Society was held at Ottawa, November 6 and 7.

The fall convention of the Connecticut Beekeepers Association was held at the state capitol, Hartford, October 11.

Dr. J. H. Merrill, assistant entomologist of the Kansas Agricultural Experiment Station, is now state apiarist of Kansas.

Dr. L. O. Howard attended the meetings of the National Academy of Sciences at New Haven, Conn., November 11 and 12, 1919.

According to *Science*, Major General W. C. Gorgas has been elected an honorary member of the National Academy of Medicine of Peru.

Prof. H. A. Gossard of the Ohio Station visited the Gulf states early in September and visited the State Entomologist of Georgia, on his way home.

Mr. Rossiter D. Olmstead has recently been appointed assistant in entomology at the New York Agricultural Experiment Station at Geneva, N. Y.

The New Hampshire Beekeepers Association was formed at Durham, N. H., on August 19, about seventy-five being present at the meeting at the college.

According to the Ohio Experiment Station News, grasshoppers have been more abundant and have caused more damage this year in Ohio than for twenty years.

Additional resignations, Bureau of Entomology: F. L. McDonough, Tobacco insect investigations; H. F. Dietz, tropical and subtropical fruit insect investigations.

Mr. H. E. Ewing, formerly of the Iowa Agricultural College, is now connected with the Bureau of Entomology at Washington, and will give especial attention to a study of mites.

Dr. W. D. Pierce, a former member of the Bureau of Entomology, announces the incorporation of the Gage-Pierce Research Laboratories with headquarters at Denver, Colorado.

Mr. A. J. Flebut has returned from military service and has been reinstated in the Bureau of Entomology, and will have charge of the laboratory at Fresno, Cal., investigating grape insects.

Mr. C. F. Stahl, Bureau of Entomology, engaged in sugar beet insect investigations in California, reports almost complete injury of sugar beets by the curly-top leafhopper in Riverside County.

Dr. E. P. Felt read a paper before the National Association of Commissioners of Agriculture at Chicago, November 10, outlining a comprehensive program for dealing with the European corn borer.

Mr. J. C. Evenden, Bureau of Entomology, formerly entomological ranger and during the war captain in Company G, 363 Infantry, with the American Expeditionary Forces, in France, has returned to the Branch of Forest Entomology as scientific assistant and is stationed at Coeur d'Alene, Idaho, under general direction of F. G. Miller.

Mr. D. L. Van Dine, of the Bureau of Entomology, having received his discharge from the Army, was reinstated in the bureau on August 4. He returns to the malaria mosquito work at Mound, La.

Mr. C. A. Weigel, Bureau of Entomology, is in Florida making a preliminary investigation of the camphor thrips situation. A permanent assistant is to be assigned to this project in the near future.

Mr. H. F. Dietz, Bureau of Entomology, has returned from the Canal Zone where he has been conducting research and experimental work for the past year, and is now engaged in preparing a report in this country.

Mr. E. R. Barber, Bureau of Entomology, has returned to his station in New Orleans after spending several months in Cuba collecting parasites of the sugar cane moth borer for shipment to the United States.

The Northern Idaho Beekeepers Association was organized at Sandpoint June 26, 1919. Arthur Sires of Sandpoint was elected president, E. A. Anthony of Rathdrum, vice president, and E. L. Ludwick, secretary and treasurer.

A conference of entomologists was held in Columbus, Ohio, August 11, to consider the European corn borer. The conference was called by N. E. Shaw, secretary of the State Board of Agriculture, and Professor H. A. Gossard was present.

Messrs. C. A. Weigel and E. L. Chambers, Bureau of Entomology, have just completed some successful experiments in controlling the adult of the grape rootworm which appeared in great numbers in a local greenhouse damaging roses.

Mr. M. M. High, Bureau of Entomology, in charge of sweet-potato weevil investigations in Texas, will visit points in the interior of Mexico for the purpose of securing parasites of the sweet-potato weevil for introduction into the United States.

Mr. F. H. Wolley Dod of Midnapore, Alberta, B. C., died July 24, 1919. Mr. Dod was a pioneer collector and student of the lepidoptera of Alberta, especially Noctuidae, and he has published many articles in *Canadian Entomologist* during the past twenty years.

Prof. Vernon L. Kellogg has been elected executive secretary of the National Research Council. Professor Kellogg is also chairman of the Councils division of educational relations, and a director of the American Relief Administration European Children's Fund.

Dr. M. C. Tanquay, associate professor of entomology, Kansas State Agricultural College, has resigned to accept the position of state entomologist of Texas, and chief of the division of entomology of the Texas Agricultural College. His resignation takes effect February 1, 1920.

Mr. W. R. Walton of the Bureau of Entomology in charge of cereal and forage crop investigations has recently made a tour of the Middle West, Pacific Northwest, and Southwest, visiting the laboratories under his direction, and called upon Director Hecke of Sacramento, California, August 8.

Mr. F. C. Bishopp of the Bureau of Entomology spent a large part of the month of August traveling in Arizona with the Arizona "Live Stock Squad." Public meetings and demonstrations were held in various parts of the state in the interest of the live stock industry. He reports a very successful trip.

Additional transfers, Bureau of Entomology: R. H. Van Zwaluwenberg, recently on European corn borer work, to Hagerstown, Md.; C. A. Bennett, Federal Horti-

cultural Board, to camphor thrips investigations, Florida; C. A. Weigel, camphor thrips investigations, Florida, to Washington, D. C.

Dr. Burton N. Gates, formerly in charge of bee culture at the Massachusetts Agricultural College, Amherst, Mass., who resigned to accept a similar position at the Ontario Agricultural College, Guelph, Ontario, Canada, has given up this position and returned to Worcester, Mass., to take up another line of work.

Mr. R. L. Webster, Department of Entomology, Cornell University, spent the month of August in southern California, studying the fumigation of citrus trees. The state insectary at Sacramento, the government entomological laboratories at Alhambra and the entomological laboratory at Riverside were visited.

Entomologists will be pleased to learn that according to the press of October 20, the Grand Duke Nicholas Micholaivitch, who was several times reported dead, is alive and for several months has been living on Prinkipo Island in the sea of Marmora. He is a well known entomologist and has published several volumes, mostly on the Lepidoptera.

Mr. George N. Wolcott, a former employee of the Bureau of Entomology, has been reëngaged to take charge of a coöperative project between the Bureau and the Bureau of Plant Industry. The project in question is an investigation of possible insect transmitters of the sugar-cane mosaic disease. Mr. Wolcott's field of operations will be Porto Rico.

The Bureau of Entomology in coöperation with the Extension Division and Department of Entomology of the University of Wisconsin, gave an extension short course for commercial beekeepers at Madison during the week of August 18. The meetings were in the nature of a Chautauqua. The total attendance was 160, the largest at any such school to date.

Additional appointments, Bureau of Entomology: Samuel Blum, Cornell University scientific assistant, Southern corn root-worm investigations, Columbia, S. C.; Joseph Edwin Fouser, Ohio State University, scientific assistant in testing proprietary insecticides; M. D. Leonard, Cornell University, and H. W. Allen to European corn borer investigations, Arlington, Mass.

According to *Canadian Entomologist*, Mr. W. Downes, temporary assistant at the Dominion Entomological Laboratory at Victoria, B. C., has been appointed a junior entomologist and will assist Mr. R. C. Treherne, entomologist in charge for British Columbia, in the investigations on small fruit insects that are being conducted on Vancouver Island and the Lower Fraser Valley.

Arrangements have been made by the Bureau of Entomology in coöperation with the extension services of the several states to conduct short courses for commercial beekeepers this fall as follows: North Yakima, Wash., Nov. 10–15; Davis, Cal., Nov. 17–22, Fresno, Cal., Nov. 24–29; Riverside, Cal., Dec. 1–6; San Diego, Cal., Dec. 8–13; San Antonio, Tex., Dec. 15–20; Manhattan, Kans., week of February 8; Ithaca, N. Y., week of February 23, 1920.

Observations in Virginia, Maryland, and New Jersey on the Colorado potato beetle indicate that extensive parasitism explains the material decrease in numbers during the present season. In the individuals of the first generation more than 25 per cent appear to have been parasitized, while parasitism in the second generation is almost complete. Workers in a position to observe and transmit to the Bureau of Entomology parasitized individuals of the Colorado potato beetle will confer a favor by so doing.

Mr. Ernest Hargreaves, who visited the United States in 1915, entered the British military service soon afterward, and was engaged during the remainder of the war, spending most of the time in Italy on anti-malaria work, which was very successful, has been discharged from military service and is now demonstrator in entomology at the Imperial College of Science and Technology, South Kensington, London.

Recent appointments to the Bureau of Entomology are as follows: Prof. S. T. Howard, Clemson College, S. C., as mechanical engineer, boll weevil force, Tallulah, La.; G. D. Dorrah, J. H. Huff, C. P. Smith, M. C. Rogers, C. H. Williams, (temporarily) boll weevil force; L. B. Sanderson, W. G. Bemis, F. W. Grigg, E. M. Searls, H. R. Carpenter, H. L. Parker, B. E. Hodgson, H. J. Cronin, C. S. Anderson, H. J. Authier, F. L. O'Rourke, J. H. Kelley, C. W. Knapp, corn borer laboratory, Arlington, Mass.

A hearing was held in Washington, D. C., October 8 regarding an appropriation to check the spread of the European corn borer, before a subcommittee of the United States Senate. There were present commissioners of agriculture from Massachusetts, New York, Delaware and Virginia and the following entomologists: E. P. Felt, P. J. Parrott, C. R. Crosby, New York; W. E. Britton, Connecticut; J. G. Sanders, Pennsylvania; E. N. Cory, T. B. Symons, Maryland; W. P. Flint, Illinois; E. D. Ball, Iowa.

Recent transfers in the Bureau of Entomology have been announced as follows: William O. Ellis, Japanese beetle investigations, Riverton, N. J. to European Corn Borer work; F. L. Simanton, Benton Harbor, Mich., and Monticello, Fla., to Hessian fly work at Centralia, Ill.; C. F. Turner, West Lafayette, Ind., to take charge of the European Corn Borer work at Schenectady, N. Y.; George B. Fisher, corn borer work, Arlington, Mass., to Hessian fly work, Wichita, Kans.; R. J. Fiske, Columbia, S. C., to West Lafayette, Ind.

T. E. Holloway, of the Bureau of Entomology, reports that the Cuban parasites of the sugar-cane moth borer, which were imported during the past summer, were allowed to emerge in cages at his laboratory in Audubon Park, New Orleans, and were then released on three plantations in different parts of southern Louisiana. He has just found that they are breeding at all three plantations, having passed through probably three generations in Louisiana. The prospect for establishing them, if they can live through the winter, is very good.

Annual meetings of various beekeepers associations were arranged to be held as follows: Eastern New York Beekeepers Association, County Court House, Albany, Nov. 20; Western New York Honey Producer's Association, Genesee Hotel, Buffalo, Nov. 14 and 15; Michigan Beekeepers Association, Lansing, Dec. 9 and 10; Ontario Beekeepers Association, Carls Rite Hotel, Toronto, Dec. 11, 12 and 13; Illinois State Beekeepers Association, Springfield, Dec. 9 and 10; Kansas Beekeepers Association, Topeka, Dec. 18 and 19; Northern Illinois and Southern Wisconsin Beekeepers Association, Rockford, Ill., October 21.

In a recent communication from Dr. O. F. E. Winberg of the Bureau of Entomology, who has been acting in charge of the work against the sweet-potato weevil in the state of Alabama, it is stated that the most thorough investigations and inspections so far during the present harvest season have failed to show the presence of the weevil in the Grand Bay district, in which a small number of farms showed infestation two years ago. The measures adopted have been the destruction of all infested sweet potatoes, through clean culture, hogging down the infested patches, and careful inspection of new plants known to be weevil free or to have been brought from weevil-free districts.

The outlook accordingly is very encouraging, and it is hoped that additional efforts in the adjoining portions of Mississippi may accomplish the same benefits and that work for another season or two in Baker County, Fla., may be equally productive.

The use of the aeroplane for scouting for the pink bollworm has been reported in previous issues of the Monthly Bulletin (California) of the old Horticultural Commission. This work recently has received a serious setback as the result of a fatal accident which happened on August 7, in which both Lieutenant Tillisch, pilot, and E. L. Diven, the technical observer of the board, lost their lives. Lieutenant Harold Compero, of the office of pest control of this department, was the original pilot and when mustered out was relieved by Lieutenant Tillisch. The flights had been conducted for a considerable period without serious accident. The danger of this service was fully recognized, but it was hoped the board's record would be a clean one, except as to accidents of a minor character. Both Lieutenant Tillisch and Mr. Diven were men of high character and undertook the work with a full realization of the personal risk.

Director Hecke of California has received advices from E. W. Rust, parasite collector attached to the office of pest control of the new Department of Agriculture, that he safely arrived at Cape Town, August 13 last. Mr. Rust will be engaged for some time in locating, rearing and packing beneficial insects for transportation to California, where they will be propagated for use in black scale and mealybug infested localities. Mr. Mally, the entomologist at Cape Town, has furnished Mr. Rust with all the facilities at his command, including a well-equipped laboratory. From Cape Town Mr. Rust will proceed to Pretoria, where he will confer with C. P. Lounsbury, entomologist for the S. A. Department of Agriculture, the governor-general and the minister of agriculture. On the voyage to Cape Town Mr. Rust was in company with the African Expedition of the Smithsonian Institute at Washington, D. C. In the expedition were Edmund Heller, biologist, late of the Roosevelt Expedition, in charge of the party, Dr. Shantz, botanist, Dr. Raven, zoölogist, and six other members, representing the moving pictures and newspapers.

Resignations from the Bureau of Entomology have been announced as follows: M. R. Smith, South Carolina; J. D. Smith, Charksville, Tenn.; R. L. Nougaret, Fresno, Cal., to become head viticulturist of the California State Horticultural Commission; Lester E. Palmer, Federal Horticultural Board; A. E. Mallory, Greeley, Colo., to enter educational work; H. K. Laramore, Plymouth, Ind., to enter commercial work; F. M. Wadley, Muscatine, Iowa, to complete his studies for an advanced degree at the Kansas Agricultural College; Neil F. Howard to accept a position with the Goodyear Rubber Co., at Akron, Ohio; F. R. Cole, Forest Grove, Ore., to resume his studies at Stanford University; C. W. Curtin, D. P. Perry, A. F. Leamy, T. F. Murphy, H. E. Partridge, E. D. Lothrop, all of the corn borer laboratory, Arlington, Mass.; W. H. Dumont, to enter college; temporary employees, L. R. Wilbanks, C. P. Smith, G. W. Alexander, J. B. Pope, H. C. Young, A. L. Williamson, O. A. Hammett, C. H. Brannon, L. W. Brannon, J. P. H. Clayton, B. M. Deavenport, G. D. Dorrah, W. W. Alexander, J. T. Lewis, P. J. Wyatt, L. N. Judah, J. W. Hill, Scott C. Lyon, S. F. Gribbs, M. L. MacQueen, W. N. Haley, L. R. T. Cowen, G. L. Lott.

There has been considerable reorganization of the Federal Horticultural Board made necessary by the enlargement of its work as a result of the nursery stock, plant, and seed quarantine No. 37, and the taking over of the direction of the fumigation of railway cars, freight, etc., on the Mexican border. R. Kent Beattie has been placed in administrative charge of the enforcement of all the quarantines and orders

restricting the entry of foreign plants and plant products. This includes nursery stock and plant and seed importations, cotton importations, and importations of fruits, grains and other plants and plant products brought under restriction. E. R. Sasscer has been placed in charge of all port inspection work necessitated by the various foreign plant quarantines administered by the Department. This assignment covers the Mexican border inspection and quarantine service and the inspection offices now maintained by the Board at the principal ports of entry in the United States, namely, New York, Boston, New Orleans, San Francisco, and Seattle. The Texas border service has been enlarged by the establishment of an inspection office at Nogales with H. M. Cely, formerly connected with the Texas pink boll-worm work, in charge. The port inspection service has been further strengthened by the addition of the following new inspectors: Emile Kostal, graduate of Cornell, assigned to New Orleans; George F. Arnold, graduate of the Mississippi A. and M. College, assigned to Eagle Pass; J. B. R. Leary, graduate of the Texas A. and M. College, transferred from Dr. W. D. Hunter's roll to the port of Laredo; Maceo M. Richardson, fumigation mechanic, assigned to Brownsville; and L. L. Spessard, graduate of the University of Washington, assigned to Washington, D. C.

At the last session of the California State Legislature all agricultural work was consolidated into one Department known as the State Department of Agriculture. All pest control work is consolidated into the Office of Pest Control, of which the following is the staff:

OFFICE OF PEST CONTROL

Harry S. Smith, Entomologist in Charge

W. C. Jacobsen.....*Superintendent, Rodent Control*
D. B. Mackie.....*Field Entomologist*
H. M. Armitage.....*Assistant Entomologist*
E. W. Rust.....*Parasite Collector*
E. J. Branigan.....*Field Assistant*
A. E. Gray.....*Field Assistant*
Harold Compere.....*Laboratory Assistant*
Paul Howard.....*Laboratory Assistant*
Marshall Monroe.....*Laboratory Assistant*
W. M. Phillipson.....*Inspector*
Harry Stiner.....*Inspector*
A. A. Brock, Santa Paula.....*Collaborator*
Dr. Joseph Grinnell (Berkeley, Cal.).....*Consulting Zoölogist*
Joseph Dixon (Berkeley, California).....*Special Investigator*

Mailed, December 8, 1919

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